A REVISION
OF
OTHOLOBIUM C.H. STIRTON
(PAPILIONOIDEAE, LEGUMINOSAE)

CHARLES H. STIRTON

A thesis submitted in partial fulfilment of the requirements for the Degree of Doctor of Philosophy in the Department of Botany, University of Cape Town.

1989

Otholobium bracteolatum (Eckl. & Zeyh.) C.H. Stirton

DECLARATION

The experimental work in this thesis was performed under the supervision of Associate Professor A.V. Hall, Department of Botany, University of Cape Town, on a part time basis, from January, 1981 to February 1989.

These studies have not been submitted in any form to another University and except where acknowledged in the text or the acknowledgements, are the results of my own work.

Charles Howard Stirton

In the creative process the unconscious effect of a strong impression, even if gained from a brief encounter, often plays a more important part than a directly demonstrable influence that has penetrated the consciousness and been given verbal expression. It may be that once set down in words, an influence loses some of its image forming power.

A.M. Hammacher

ABSTRACT

This study arose from difficulties encountered in identifying *Psoralea* s.l. for the Flora of southern Africa. A worldwide assessment of the genus *Psoralea* resulted in the fragmentation of the genus into six genera: *Bituminaria*, *Cullen*, *Hallia*, *Otholobium*, *Orbexilum*, and *Psoralea*. In the course of this study a detailed comparison was made of the tribes Psoraleeae and Amorpheae. Considerable new data from phytochemistry, palynology, morphology and leaflet anatomy confirmed that they were distinct and not closely related as had been widely assumed: new characters included cotyledon type, arrangement of the embryo and radicle in the seed, seed shape, fruit morphology, chromosome numbers, petiolar anatomy, root architecture, nodule type, inflorescence architecture, 6AH-pterocarpan and 6a-hydroxy analogue chemistry, pollen anatomy and morphology. A cladistic analysis was made of the genera in the Psoraleeae.

Having broadly circumscribed the genera in the Psoraleeae it was decided to revise the new genus *Otholobium*. Considerable supporting evidence had been obtained distinguishing this genus from the other southern African genera: flavonoids, proanthocyanidins, furanocoumarins, essential oils, flower morphology, inflorescence architecture, leaflet anatomy, and geographical distribution patterns. Different classes of chemical compounds gave different levels of taxonomic information.

This revision of the endemic African genus *Otholobium*, related to *Psoralea* (including *Hallia*), *Bituminaria* and *Cullen* of the tribe Psoraleeae, is based on studies of herbarium material as well as living plants in their natural habitats and in cultivation. Fifty-three species are recognised. Sixteen species are newly described: *Otholobium accrescens* Stirton, *O. arborescens* Stirton, *O. dreweae* Stirton, *O. flexuosum* Stirton, *O. fumeum* Stirton, *O. incanum* Stirton, *O. lanceolatum* Stirton, *O. lucens* Stirton, *O. nigricans* Stirton, *O. nitens* Stirton, *O. piliferum* Stirton, *O. prodiens* Stirton, *O. pustulatum* Stirton, *O. sabulosum* Stirton, *O. saxosum* Stirton, and *O. spissum* Stirton. The following new combinations are made: *O. gazense* (Oliv.) Stirton and *O. virgatum* (Burm.f.) Stirton. Four species were described formally during the revision: *O. pictum* C.H. Stirton, *O. pungens* C.H. Stirton, *O. rubicundum* C.H. Stirton, and *O. swartbergense* C.H. Stirton. All species have been illustrated as full black and white plates.

A detailed and novel analysis has been made of the conservation status of 110 species of African Psoraleeae using information of dispersion, local population size and niche specificity. This modified system of rarity classification was supported by a wide range of variables: phenology, geological substrate, altitudinal range, fire susceptibility, and seed producing capacity. The findings have important implications for conservationists and offer real management strategies and show that plant systematists have a positive, dynamic role to play in plant conservation.

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One of the highlights of this project has been to work with a number of very talented botanical artists. Ellaphie Ward-Hilhorst has executed the colour plates in an exemplary manner. I would also like to thank Claire Smith, Ann Farrer, Rosemary Holcroft and Elenor Huxley for their contributions. A special thank you goes to Angela Beaumont who prepared the majority of the line drawings in such an attractive and meticulous manner.

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Unpublished name changes in this thesis

(a) New species

Otholobium accrescens C.H. Stirton
Otholobium arborescens C.H. Stirton
Otholobium dreweae C.H. Stirton
Otholobium flexuosum C.H. Stirton
Otholobium fumeum C.H. Stirton
Otholobium incanum C.H. Stirton
Otholobium lanceolatum C.H. Stirton
Otholobium lucens C.H. Stirton
Otholobium nigricans C.H. Stirton
Otholobium nitens C.H. Stirton
Otholobium piliferum C.H. Stirton
Otholobium prodiens C.H. Stirton
Otholobium pustulatum C.H. Stirton
Otholobium sabulosum C.H. Stirton
Otholobium saxosum C.H. Stirton
Otholobium spissum C.H. Stirton

(b) New combinations

Otholobium gazense (Oliv.) C.H. Stirton
Otholobium virgatum (Burm. f.) C.H. Stirton

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The Leguminosae comprises some 650 genera and approximately 18,000 species and is the third largest family after the Asteraceae and Orchidaceae (Polhill, Raven & Stirton, 1981). The consensus of most legume taxonomists today is that the legumes constitute a single family, best divided into three subfamilies: Caesalpinioideae, Mimosoideae and Papilionoideae (Polhill & Raven, 1981).

Throughout this study I have adopted the traditional names Leguminosae / Papilionoideae instead of Fabaceae/Faboideae. The history and controversy surrounding these names is expressed adequately and elegantly in Isely & Polhill (1980). See also page 55 in Polhill & Raven (1981).

The traditionally accepted differences between the subfamilies are listed in Table 1.1 and are supplemented by unpublished and recently published data which confirm their retention in a single family, notwithstanding some attempts to gloss over critical areas of overlap (Cronquist, 1968). Polhill, Raven & Stirton (1981) concurred that the major evidence presented in Advances in Legume Systematics, Part 1 "**would seem to support the concept of a single family, though El-Gazzar** (1981) **argues the case for two rather than three major groups**".

My recent studies on the tribe Sophoreae have shown that the actinomorphic flowers reported previously in Papilionoideae are in fact distinctly bilaterally symmetrical (*Acosmium*, Fig.1.1) and that these anomalous genera, which also produce straight

Table 1.1 Major differentiating characters of the three subfamilies Caesalpinioideae, Mimosoideae and Papilionoideae of the family Leguminosae (Data compiled from various sources, see footnotes)

Characters	CAESALPINIOIDEAE	PAPILIONOIDEAE	MIMOSOIDEAE
A. Floral ontogeny			
1. Order of initiation of sepals	helical (unidirectional)	unidirectional	helical
2. Order of initiation of organs in corolla and stamen whorls	unidirectional	unidirectional	simultaneous
3. Position of median petal in flower	adaxial	adaxial	abaxial
4. Position of median sepal	abaxial	abaxial	adaxial
5. Stage when zygomorphy becomes evident	at petal initiation	mid-stage, during stamen enlargement	at sepal initiation
B. Flower structure			
6. Flower structure	zygomorphic	zygomorphic	actinomorphic
7. Sepals in buds	valvate	valvate	imbricate
8. Sepals	free	united variously	united variously
C. Palynology			
9. Simple/compound grains (tetrads/polyads)	simple	simple	compound
D. Seed structure			
10. Development of hilum and tracheid bar	absent	present	absent
11. Curvature of radicle	straight	curved (very rarely straight)	straight
E. Biological characters			
12. Susceptibility to Uromyces rusts	resistant	susceptible	resistant

Sources: A-B, Tucker (1987b); C, Ferguson, pers. comm.; D-E, Polhill, Raven & Stirton (1981).

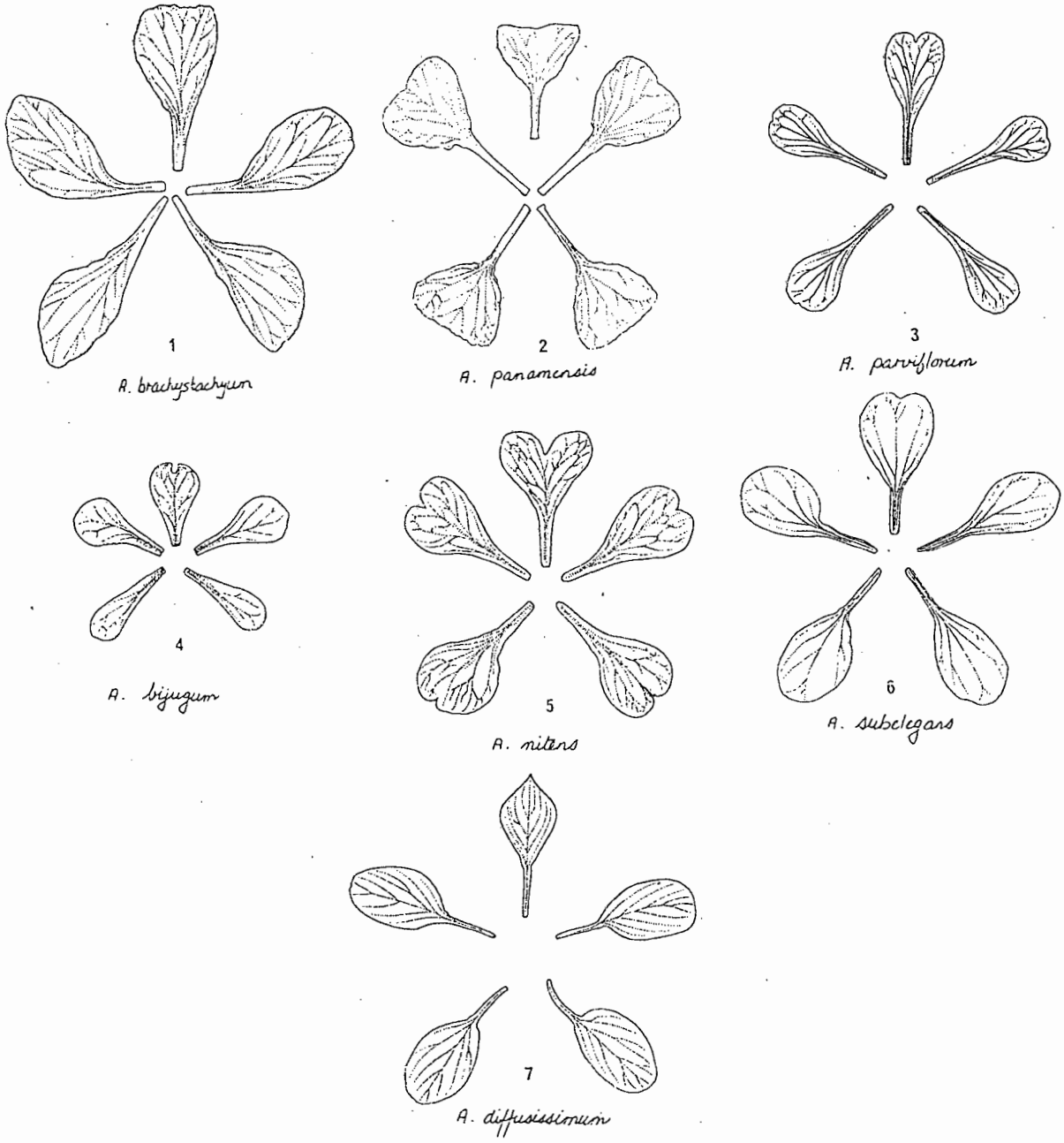

Fig.1.1 Representative corollas of seven species of *Acosmium* (Sophoreae) showing bilateral symmetry of petals.

radicles, may have done so convergently relative to Caesalpinioideae as their seeds have a very distinct tracheid bar and hilum, features characteristic of the Papilionoideae.

The Swartzieae present a problem and should, I believe, be recognized as a distinct subfamily. I do not think that they are the sister group to the rest of the Papilionoideae. Their floral ontogeny and their pollen morphology and anatomy, for example, are quite distinct in the Leguminosae (Tucker, pers. com.; Ferguson pers. com.). There are few characters which link them to the Sophoreae.

After a careful analysis of the taxonomic evidence presented in Advances in Legume Systematics, Parts 1-3 (Polhill & Raven, 1981; Stirton, 1987) I think the time has come for a new interpretation of the family, perhaps using cladistic procedures, which treats all the anomalous genera as distinct groups, for each character surveyed, and through a gradual regrouping based on more monophyletic lines proceed to a new conspectus. The tribes Amherstieae-Detarieae in the Caesalpinioideae, for example, and some of the basal Sophoreae, will certainly need to be re-aligned as will the limits of the tribes Sophoreae, Dalbergieae, Robinieae and Millettieae. Some glaring generic misplacements also need to be rectified, for example, *Glycyrrhiza* (Preface in Stirton, 1987, See Appendix VII).

1.1.1 **Background to this study**

This study began in 1977 with a general attempt to make some sense out of the large amount of undetermined herbarium material of the genus *Psoralea* available in South African herbaria. My original intention was to provide a floristic account of the genus for the Flora of Southern Africa project. However, it soon became clear that possibly more than one genus was involved and that there were an apparently large number of undescribed species. It seemed apposite therefore, as I was then soon to be appointed

the South African Liaison Officer at the Royal Botanic Gardens - Kew, that I should avail myself of the large worldwide holdings there and study the genus throughout its distribution range. This initial survey commenced in 1978 and a preliminary paper was published three years later (Stirton, 1981b). The reader is referred to this paper, reproduced in Section 1.2.

Subsequent to this initial study I contacted or was approached by a number of researchers who wished to work, either collaboratively or in parallel, in resolving a number of the problems which I had deferred pending more data: Mr. G.W. Turner (leaf and gland anatomy and development, Ames - Iowa); Mr. J.W. Grimes (Monograph of the American "*Orbexilum*" complex, Austin - Texas), Prof. J.B. Harborne (flavonoid chemistry, Reading - England); Drs. I.K. Ferguson and C. Furness (Pollen anatomy and morphology, Kew - England); Prof. S.J. Tucker (Floral ontogeny, Baton Rouge, Louisiana) and Dr. M. Simmonds (Insect feeding preference studies, Kew - England). Two of these studies were initiated as postgraduate programs (Turner; Grimes). My extensive collections of herbarium and spirit material were made available to both graduate researchers but only Turner availed himself of them. I became aware through various contacts that Grimes was initiating a number of broad-based anatomical and other studies on *Orbexilum s.l.* and allied genera which included those that I was studying. As I did not receive any communications from Grimes I decided to avert any possible duplication of effort by restricting my own studies to a morphologically based taxonomic revision of *Otholobium*, a new genus I had described in my initial survey; with some emphasis on the application of microcomputers in taxonomic revisions, phytogeography, conservation status of African Psoraleeae and an update on generic relationships within the tribe Psoraleeae using cladistic methods. I have also been monographing *Psoralea* s.l. (47 species). However, in this thesis I will only refer to *Psoralea* in part wherever they aid in understanding some of the morphological diversity found in *Otholobium*. Both Grimes (1986) and Turner (1986) have now published some of their

preliminary results and I will refer to these where appropriate in the following chapters.

1.2 **The tribe Psoraleeae**

Psoralea s.l., of the tribe Psoraleeae, subfamily Papilionoideae, is a medium sized, widely distributed, rarely tropical, genus of some 200 species.

The most up to date revision of the tribe Psoraleeae and its affinities with the tribe Amorpheae is given in Stirton (1981b) which is reproduced below. Since this paper was published there have been a number of developments which necessitate some alterations and additions to the text. I have marked the reproduced text accordingly and provide explanatory notes in the next section.

1.2.1 **Explanatory notes on Stirton (1981b).**

1. Examples are now known in *Psoralea* in which glands are found on the surface of the standard petals: *P. ensifolia* (Houttyn) Merrill and *P. repens* Bergius (Fig. 1.2). They do not occur on any of the other species of African psoraleoid legumes. The glands correspond in nature and ontogeny to the typical glands of the Psoraleeae and are quite different from those found in the Amorpheae; the latter is a tribe which characteristically has glands on its petals. The glands found in *Psoralea* are ontogenetically distinct (Turner, 1986; pers. comm.).

2. Leaves of *Psoralea* may be scalelike, 1-, 3-, 5-, 7-, 9-, or 11-foliolate and may exhibit a wide range of variation in number between juvenile and adult plants and between macroblasts and brachyblasts (See chapter 2.2.2.1.4). The pattern of leaflet number is laid down at the seedling stage and is discussed in Chapter 2.2.2.1.3.

Tribe 11. PSORALEEAE (Benth.) Rydb. (1919)*

Small trees, shrubs, suffrutices, rarely annual herbs; variously glandular-punctate, never on petals; leaves 3-foliolate, rarely 1- or 5-foliolate or reduced to scales, entire or (*Cullen*) denticulate, alternate to distichous; stipels absent; stipules adnate to petiole, fused or free, stem-clasping, rarely (some *Hallia*) recurved; inflorescences indeterminate, paniculate, based on unit structure or 3 flowers per node from which reduction series give rise to 1–6-flowered racemes or capitula; bracteoles rare, reduced; calyx campanulate, upper lobes partially fused; petals free from staminal column; standard weakly clawed, rarely (*Psoralea*) with appendages; wing petals sculptured, lamellate; keel purple-tipped; vexillary stamen free from the base or fused with others into an adaxially split sheath; anthers uniform, alternately versatile and basifixed; pollen 3-colpate, operculate, or 3-colporate with endopore, tectum perforate, finely reticulate, wall stratification with thin endexine, clear foot-layer, distinct columellae and tectum; ovary (*Psoralea*) strongly stipitate, substipitate or sessile, uniovulate, hairy or sparsely covered with recurved club-shaped glands; style upcurved, penicillate, rarely glabrous; fruits indehiscent, pericarp chaffy (*Psoralea*), woody, verrucose (*Cullen*) or pod-like; seeds exarillate; cotyledons well developed, embryo jack-knifed with cotyledons and stalk almost parallel, subequal in length to longer than broad seed. 2n=22 (*Bituminaria* 2n=20). Six genera, widely dispersed, rarely tropical.

This study supports Barneby's (1977) decision to combine Daleae Hutch. and the genera *Parryella, Eysenhardtia, Psorobatus, Psorodendron, Psorothamnus, Apoplanesia, Marina* and *Amorpha* of Psoralieae Hutch. into the tribe Amorpheae.

The Amorpheae and Psoraleeae so emended are thought by Barneby (1977) to be phylogenetically distinct and perhaps not even close kindred. In Barneby's view the Amorpheae and Psoraleeae differ in their branching patterns, total anthotaxy and to a lesser extent on petal insertion, foliage and geographical distribution. The growth of stems in Amorpheae is determinate, the arrangement of the inflorescences cymose and centrifugal, the petals mostly epistemonous, leaves basically pinnate, and distribution North American. The Psoraleeae by contrast have an indeterminate growth of stems, racemose and acropetal inflorescences, basically trifoliolate leaves, and a distribution mostly south of the equator in the Old World and north of the equator in the New.

This study makes use of several new characters which also confirm Barneby's separation of Psoraleeae and Amorpheae. These include the cotyledons, the arrangement of the embryo and radicle in the seed (fig. 1/1–8), seed shape, fruit structure (fig. 1/9–32) and pollen (Ferguson & Skvarla, this volume). Other characters which are rather variable and still poorly known, but which may be useful in the future, are the structure of glands, petiolar anatomy and chromosome number. The nature of glands is rather variable in each tribe, but more so in the Psoraleeae. There appears to be no overlap. In general, the nature, ontogeny and function of glands in the Papilionoideae are poorly known and very much in need of investigation. In the Amorpheae the petiole appears to have a basic structure of a single, thick fibre ring whereas in the Psoraleeae there are scattered fibre bundles or a broken ring of fibre bundles. Chromosome number is less clear-cut than petiolar anatomy and gland structure. The Psoraleeae have x=10 and 11; the Amorpheae x=7, 8 or 10. The basic number is probably x=10 in Amorpheae and x=11 in Psoraleeae (Goldblatt, this volume).

What features do the Amorpheae and Psoraleeae have in common? Three characters seem to counter-argue for their unification into a single tribe. Firstly, according to Lersten & Wemple (1966, see for further references) and Isely (pers. comm.) the two tribes possess a unique feature, the discontinuity plate, i.e. xylem discontinuities in the ovary traces to the receptacle (fig.2c). It is difficult to interpret the nature, origin and functon of this

*By C.H. Stirton

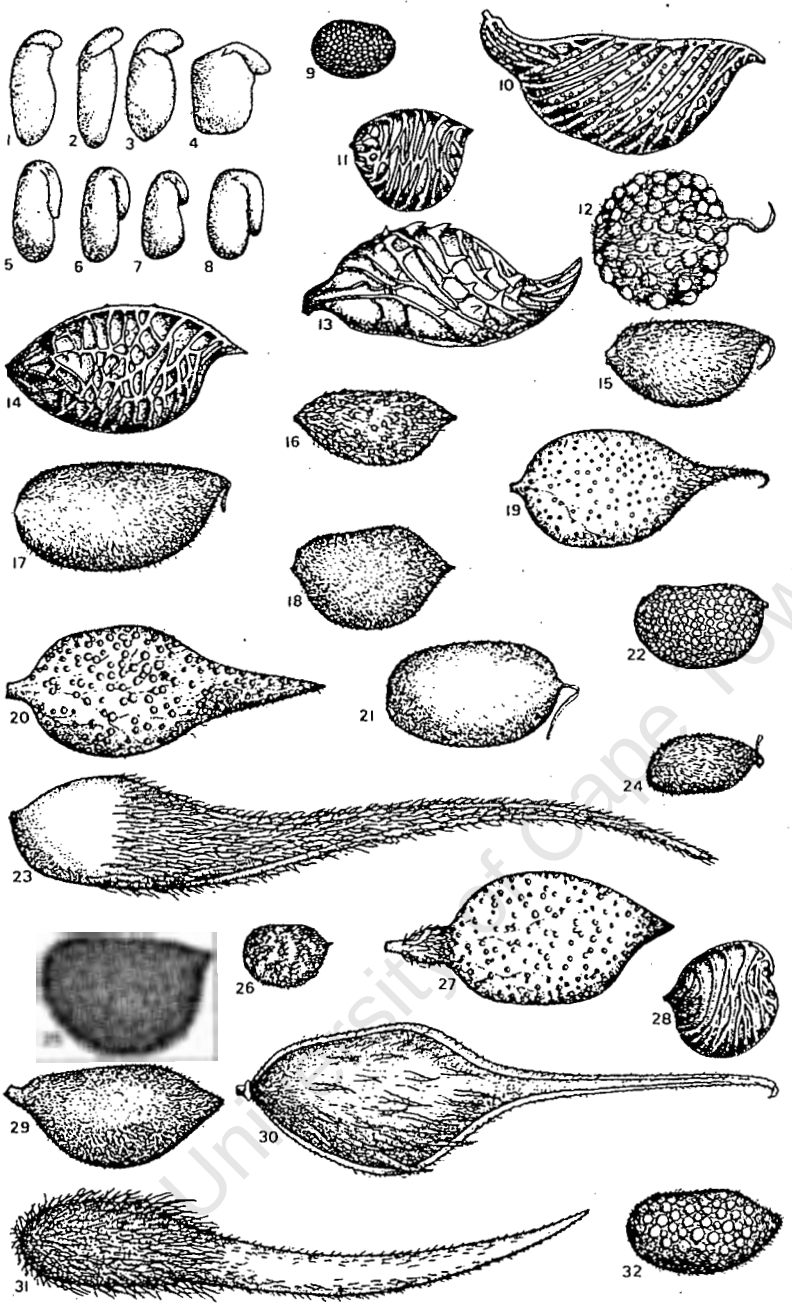

Fig. 1 A – Representative types of cotyledons (×1) in Amorpheae (1–4) and Psoraleeae (5–8); B – Representative types of fruits (×6) in Psoraleeae: 9 *Psoralea tenax (Cullen)*; 10 *P. lupinellus (Orbexilum)*; 11 *P. virgata (Orbexilum)*; 12 *P. micrantha (Orbexilum)*; 13 *P. melanocarpa (Orbexilum)*; 14 *P. onobrychis (Orbexilum)*; 15 *P. albida (Orbexilum)*; 16 *P. lasiostachys (Cullen)*; 17 *P. pubescens (Orbexilum)*; 18 *P. wilmsii (Otholobium)*; 19 *P. cuspidata (Orbexilum)*; 20 *P. canescens (Orbexilum)*; 21 *P. pinnata (Psoralea)*; 22 *P. corylifolia (Cullen)*; 23 *P. esculenta (Orbexilum)*; 24 *P. plicata (Cullen)*; 25 *P. drupacea (Cullen)*; 26 *P. plumosa (Cullen)*; 27 *P. tenuiflora (Orbexilum)*; 28 *P. eglandulosa (Orbexilum)*; 29 *P. foliosa (Otholobium)*; 30 *P. acaulis (Bituminaria)*; 31 *P. bituminosa (Bituminaria)*; 32 *P. pustulata (Cullen)*.

distinct, although not universal, anatomical structure, particularly bearing in mind the complex nature of inflorescence structure and evolution in both tribes, both of which have markedly contracted inflorescences often reduced to single flowers. Such a structure may well reflect the past history of inflorescence contractions. Perhaps the known variability may also be indicative of a correlation between fruit type and the degree of development of the plate. Species of *Psoralea* sensu Lersten & Wemple (1966), for example, have markedly different fruits (fig. 1/9–32) and a considerable variation in the degree of development of the plate. As these authors do not cite voucher material and deal with only a small number of species it is difficult to recast their results in current generic and tribal delimitations. Their data on the discontinuity plate has been invoked to reflect at least an early common ancestry between the two tribes. In my opinion there is insufficient data on which to base such a confident assessment.

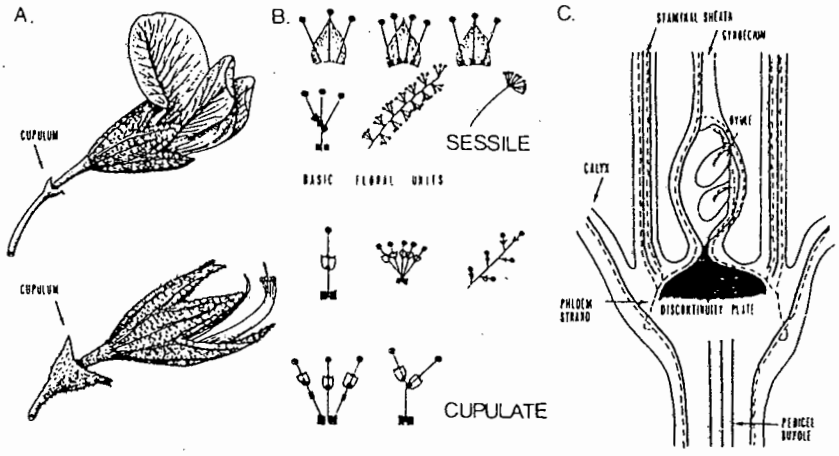

Fig. 2 A. Flowers of *Psoralea oligophylla* and *P. pinnata*. Arrows indicate the unique cupulum found in *Psoralea* and *Hallia*. B. Basic floral units and inflorescence types in Psoraleeae. All genera except *Psoralea* and *Hallia* have a basic floral unit of three sessile flowers each subtended by a small bract and the whole unit by a large single bract. *Psoralea* and *Hallia* are characterised by the present of a cupulum and pedicellate floral units. C. Diagrammatic longitudinal section of the basal portion of a flower of *Petalostemon* (Amorpheae). Heavy black lines, xylem; dashed lines, phloem (after Lersten and Wemple, Amer. J. Bot. 53: 548–555, 1966). The discontinuity plate is shaded black.

Lersten (pers. comm.) also feels that the nature of the internal secretory cavities in Amorpheae and Psoraleeae are a second uniting feature. He cites as evidence Moore's unpublished data based on cleared and sectioned leaflets of 104 species of *Psoralea*. Moore is reported by Lersten (pers. comm.) to have found four conditions:

1. No cavities (5 *Hallia* spp.)
2. Local areas of elongated epidermal cells (only *P. acaulis*)
3. Spherical internal cavity formed by greatly elongated epidermal cells with extremely slender shank
4. Spherical internal cavities lined with an epithelium (only *P. aculeata* and widespread in Amorpheae and Psoraleeae generally)

As with the discontinuity plate this information is difficult to interpret, especially without voucher material. However as these data may be promising even at generic level the study should be expanded to all genera of both tribes. The third broad character that may unite both tribes is the

general adnation of stipules to the petiole, but again there are exceptions.

These structures notwithstanding, the cumulative evidence, particularly from pollen, inflorescence and seed structure, would suggest that Barneby (1977) is correct in separating the two tribes. It must also be clearly stated, however, that the question of their phylogenetic affinity is unresolved, especially as there are still few clues to suggest where their natural affinities may lie in relation to other tribes.

After a critical inspection of the remaining ten genera accepted by Hutchinson (1964), now that eight have been transferred to the Amorpheae, it becomes necessary to reallocate species into six genera: *Psoralea, Hallia, Cullen, Bituminaria, Otholobium* and *Orbexilum*. This redelimitation has been based on detailed dissections of flowers, inflorescences, fruits and seeds, including leaf arrangement and leaf morphology. An attempt has been made to interpret the various types of fruits, flowers and inflorescences, not as variants of a typological series, but rather as successful compromises of structure; function and operation that exist within the limits posed by certain genetic constraints. For the most part variation has been in Psoraleeae, as in most Leguminosae, merely uncritically mapped and described. Seldom has recognition been given to the existence of convergences, adaptive radiations and genetic canalisations; phenomena which are critically important to understand if taxa are to be allocated and grouped in a natural sense (see Introduction). These considerations are implicit in the reorganisation of Psoraleeae. *Psoralea* sensu Hutch. has been rearranged as follows.

Psoralea is restricted to only 20 species mostly endemic to the Mediterranean areas of southern Africa. The remaining species are assigned to other genera. The new genus *Otholobium* is established to accommodate some 20 species centred in the eastern region of southern Africa, with outliers as far north as East Africa. The genus *Cullen* is considerably expanded to include the remaining six species of *Psoralea* from Africa, the genus *Meladenia* Turcz., as well as most other Asian and all Australian species currently referred to *Psoralea*. The essentially European genus *Bituminaria* comprises two species and perhaps has conspecifics in north America (e.g. Rydberg's *Pediomelum*). This leaves all the American species of *Psoralea* sensu Hutch., which I collectively refer to *Orbexilum* being the earliest available name for these plants. This group of plants, while distinct from the African, Asian and Australian Psoraleeae, is on the one hand too heterogenous a group to be acceptable as a single taxon (Isely, 1958) and on the other not acceptably divisible into too many minor segregate genera (Rydberg, 1919). The genus *Orbexilum* is clearly in need of a monographic study over its entire distribution range.

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References

Barneby, R.C. (1977). Daleae Imagines. Mem. N.Y. Bot. Gard. 27: 1–891.

Hutchinson, J. (1964). 'The Genera of Flowering Plants', Vol. 1. Oxford University Press.

Isely, D. (1958). Leguminosae: Psoraleae of the United States. A generic summary. Iowa St. Coll. J. Sci. 33: 23–36.

Lersten, N.R. and Wemple, D.K. (1966). The discontinuity plate, a definitive floral characteristic of the Psoraleae (Leguminosae). Amer. J. Bot. 53: 548–555.
Rydberg, P.A. (1919–1920). Fabaceae: Psoraleae, in North Amer. Fl. 24: 1–136.

1 Flower-pedicel subtended by a distinctive lobed cupulum (fig. 2A)
  3 Calyx-lobes covered with black stubby hairs on inner face, tube prominently ribbed and encrusted with glands; internal secretory cavities present in leaflets 11.1 *Psoralea*
  3 Calyx-lobes not covered with black stubby hairs on inner face, tube weakly ribbed and sparsely glandular; internal secretory cavities absent in leaflets 11.2 *Hallia*
2 Flower-pedicel never subtended by a cupulum:
  4 Fruit oval, conspicuously black glandular warty when mature 11.4 *Cullen*
  4 Fruit never black glandular warty:
    5 Leaflets recurved-mucronate; southern and eastern Africa 11.3 *Otholobium*
    5 Leaflets not recurved-mucronate; Mediterranean, Europe and the Americas:
      Mediterranean Europe 11.5 *Bituminaria*
      North and South America 11.6 *Orbexilum*

11.1 PSORALEA L. (1753); Hutch. 418 (1964), pro parte; lectotype *P. pinnata* L. *Ruteria* Medik. (1747). About 20 species endemic to South Africa, most of them restricted to the Cape Province and about two extending as far north as Swaziland.

Small trees, shrubs or suffrutices, covered in prominent blackish-red glands, especially on the calyx; leaves digitately 3-foliolate, 3–5-pinnate, 1-foliolate, or rarely reduced to scales, leaflets entire; stipules embracing the stem by the broad base, fused to petiole near the base; flowers axillary, fasciculate, 1–5, each with or without a bract but always subtended by a lobed cupulum (fig. 2) which itself is subtended by 2 free bracts; bracteoles absent; calyx-lobes equal, upper 2 mostly connate, inner face of lobes invested with stubby black hairs; petals blue; standard orbiculate, appendaged above the claw with inflexed auricles; wings longer than keel, distinctly keeled above claw; keel incurved, shortly clawed, somewhat falcate, with darker patch at tip; vexillary stamen free, arching over ovary chamber; anthers uniform, alternately basifixed and versatile; ovary distinctly stipitate, 1-ovulate, glabrous with a few scattered recurved club-headed glands; style glabrous, dilated at the base, incurved in upper part; stigma penicillate; fruit (fig. 1.21) enclosed by calyx at maturity, ovate, indehiscent; pericarp reticulately veined, fragile; seeds black, shortly funiculate.

Some confusion has arisen over both the spelling and the typification of *Psoralea*. Linnaeus used *Psoralia* in his Genera Plantarum, ed. 5: 336 (1754) but *Psoralea* in the Species Plantarum: 1762 (1753). *Psoralia* was used again in Gen. Pl., ed. 6: 386 (1764) in the text, whereas it was spelt *Psoralea* in the index. After this *Psoralea* was used more consistently than *Psoralia* (e.g. Syst. Nat., ed. 12, 2: 500 (1764) and Suppl. Pl.: 500 (1781)). As *Psoralea* is also philologically more correct it is adopted as the correct spelling (Art. 74). A problem of typification arises because Medikus (Vorles. Churpf. Phys.-Oek. Ges. 2: 380–382 (1787)) reallocated to new genera some but not all of Linnaeus's original eight species. It could be argued that this first reorganisation of the Linnaean species effectively lectotypified the genus. *Psoralea* in Medikus's sense is quite different however from that of Linnaeus, whose protologue of the genus in Gen. Pl. ed. 5 (1754) clearly best matches *Psoralea pinnata* and *P. aculeata*, the two original Van Royen phrase names on which the genus is based. *Psoralea* sensu Medikus is based on the unrelated species *P. americana* L. and *P. glandulosa* L. These two plants are considerably different. The former is closely related to *P. corylifolia* L., the type of *Cullen* Medikus, whereas *P. glandulosa* is an *Orbexilum* sensu lato. *P. pinnata* which is reaffirmed here as the lectotype of *Psoralea* was placed by Medikus in a new genus *Ruteria*. Two factors support the choice of *P. pinnata*; firstly, Linnaeus's unambiguous generic description and secondly Medikus's ambiguous description based on mixed elements (see also Hitchcock & Green, Int. Bot. Congr. Cambr. 136 (1930)).

11.2 HALLIA Thunb. (1799); Hutch. 419 (1964). 9 species endemic to Mediterranean region of South Africa.

Low ascending or trailing suffrutices; leaves 1-foliolate, exstipellate, alternate, simple, entire, often nigropunctate; stipules striate, adnate at the base of the petiole; flowers axillary, solitary, slender pedunculate or subsessile, each bracteate and always subtended by a lobed cupulum which itself is subtended by 2 bracts; bracteoles absent; calyx-lobes equal, longer than tube, 2 upper slightly connate, inner face without black stubby hairs as in *Psoralea*; petals purple, standard ovate, without appendages, auricles inflexed but weakly developed; wings oblong, longer than the obtuse keel; stamens monadelphous; ovary weakly substipitate, 1-ovulate; fruit compressed, thinly membranous and reticulated, enclosed by the calyx at maturity.

11.3 OTHOLOBIUM Stirton gen. nov.; type *Otholobium caffrum* (Eckl. & Zeyh.) Stirton (*Psoralea caffra* Eckl. & Zeyh., Enum. 230 (1836)). About 20 species mainly restricted to south-eastern and eastern Africa, but also extending into the Mediter-

ranean region of South Africa. The new combinations are to be published elsewhere. 2n=20.

Frutices vel suffrutices, raro herbae decumbentes; folia trifoliolata, stipulata, petiolata, foliolis integris, nigro-punctatis vel pellucido-punctatis, obovatis, oblanceolatis, cuneatis, apice acuto usque obtuso recurvo-mucronato; stipulae liberae vel petioli basi adnatae; flores albi, lutei vel pallide caerulei, sessiles vel subsessiles, aut in triades (raro paria) 1 vel 5–18 aut in fasciculos axillares vel terminales aut in racemos imperfectos aut in pseudo-spicas laxas aggregati, quoque flore bracteato, triadibus bractea singula ovata suffultis, cupula nulla; vexillum ovato-oblongum, ungue et auriculis pampere evolutis, appendiculis nullis; alae carinam valde excedentes; stamen vexillare liberum; ovarium sessile, 1-ovulatum, stylo tumido, stigmate capitato penicillato vel glabro; fructus tumidus, pubescens, leviter rostratus, maturus e calyx exsertus; semen nigrum, longius quam latius.

Shrubs, suffrutices or rarely decumbent herbs; leaves 3-foliolate, stipulate, petiolate, the leaflets entire, nigro-punctate or pellucid-dotted, oblanceolate, cuneate, acute or obtuse, recurved-mucronate; stipules striate, ovate-acute or subulate-acuminate, pubescent, free or adnate to the base of the petiole; flowers white, yellow or pale blue, sessile or subsessile, aggregated in 1 or 5–18 triplets, or rarely doublets, axillary or terminal fascicles, imperfect racemes or lax pseudo-spikes, each flower bracteate, triplets subtended by a single ovate bract, cupulum of *Psoralea* and *Hallia* absent; calyx campanulate, unequally 5-lobed, the lowest lobe much longer and broader than the rest, upper lobes variously connate, very rarely stubby black haired on inside; standard ovate-oblong, claw and auricles weakly developed, appendages absent; wings much exceeding keel, sculpturing lamellate; keel long-clawed, purple-tipped, obtuse; vexillary stamen free; anthers uniform, alternately basifixed and medifixed; ovary sessile 1-ovulate, glabrous and glandular, or hairy; style swollen; stigma capitate, penicillate or glabrous; fruit swollen, indehiscent, pubescent, slightly beaked, protruding from calyx at maturity; seed longer than broad, black.

21. 11.4 CULLEN Medik. (1787); Hutch. 419 (1964). *Dorychnium* Moench. (1794), pro parte; *Meladenia* Turcz. (1848); *Bipontinia* Alef. (1866). 35 species, a few in the drier regions of Africa but most extending through India and Sri Lanka to Burma, Philippines, Papua New Guinea and Australia.

Shrubs, suffrutices or herbs; leaves 3–1-foliolate or rarely if digitately 3–5-foliolate then leaflet margins entire, otherwise either coarsely dentate and conspicuously gland-dotted to undulate and repand-denticulate and black punctate; leaflets ovate, lanceolate, orbiculate or elliptic, never strongly obovate and recurved-mucronate as in *Otholobium*, glabrous to densely pubescent; stipules linear-subulate, free and adhering to the base of leaf-rhachis, persistent; flowers scarcely exceeding calyx, purple, purple-blue, rarely pale-coloured, sessile, occasionally subsessile, aggregated in 3–40 triplets into long axillary pedunculate spikes or shortly pedunculate or subsessile axillary clusters, each triplet of flowers subtended by a single ovate bract, cupulum absent; calyx either glabrous or strongly glandular-punctate, campanulate with lowest lobe longest, or densely pubescent, sparsely glandular and bilabiate with lowest lobe longest and upper lobes connate high up; standard narrowly obovate or obovate with weakly developed claw and auricles and without appendages; wings longer than keel, oblong with prominent basal lobe, sculpturing well developed; keel broadly obliquely lunate; vexillary filament free or subbasifixed, rest united into a sheath slit adaxially, base billowy and constricted; anthers uniform, alternately basifixed and versatile; ovary substipitate, either glabrous with club-headed glands or pubescent; style upcurved, slender, rarely swollen; stigma either minute or capitate, rarely penicillate; fruit erect, conspicuously glandular-warty, glabrous or white pubescent, indehiscent; pericarp very thin, adherent to seed; seed obliquely reniform. 2n=22.

22. 11.5 BITUMINARIA Heist. ex Fabricius, Enum.: 165 (1759); *Aspalthium* Medik. (1787); Hutch. 420 (1964). *Rhynchodium* Presl. (1844), pro parte. 2 species endemic to Mediterranean Europe, North Africa and Euxine. (The new combinations are to be published elsewhere); type *Bituminaria bituminosa* (L.) Stirton.

Herbaceous perennials; leaves cauline or acauline, pinnately or subdigitately 3-foliolate, linear-lanceolate to broadly-ovate with entire margins, or broadly ovate to orbicular with irregularly denticulate margins, gland-dotted, shortly or stiffly pubescent; stipules linear-subulate, persistent; flowers sessile or subsessile, aggregated in 5–16 triplets into long pedunculate axillary capitate-umbellate or compact racemose inflorescences, each triplet subtended by a single variously 3(–5)-cleft bract, becoming smaller, narrower higher up or wanting at the apex, individual flowers bracteolate (*B. acaulis*) or ebracteolate (*B. bituminaria*); calyx with long setaceous teeth exceeding the tube, upper lobes joined higher or not; corolla scarcely exceeding the sharply subulate-tipped calyx-lobes, blue, violet or creamy-white; standard narrowly obovate with weakly developed auricles, flattish claw and no appendages; wings longer than keel, partially attached, sculptured; vexillary filament attached for about half its length to the adaxially split sheath which is billowy and constricted at its base; anthers oblong, alternately long-basifixed and short-versatile; ovary substipitate, pubescent;

style upcurved and thickened at the point of flexure; stigma somewhat flattened, penicillate; intrastaminal nectary present; fruit indehiscent, with a long sword shaped beak and furnished with glabrous spinulose or soft pubescent processes; pericarp adnate to the seed or free; seed dark brown, oblong or obliquely reniform. 2n=20.

11.6 ORBEXILUM Raf. (1832); Hutch. 418 (1964); type *Orbexilum latifolium* (Nutt.) Raf. *Pediomelum* Rydb. (1919); Hutch. 417 (1964). *Hoita* Rydb. (1919); Hutch. 418 (1964). *Rhytidomene* Rydb. (1919); Hutch. 418 (1964). *Psoralidium* Rydb. (1919); Hutch. 419 (1964). About 50 species occurring mainly in North America with some groups extending through Central America into South America. 2n=22.

This group of North and South American plants is all that remains once the genera *Psoralea, Hallia, Otholobium, Bituminaria* and *Cullen* have been separated off. Clearly this is an unsatisfactory assemblage of plants and as Rydberg (1919–1920) and Hutchinson (1964) have already indicated it can be divided into a number of natural groupings of apparently various taxonomic rankings; groupings which the present author arrived at without any prior knowledge of the American plants. Until a monographic revision is made of all the American Psoraleeae including European *Bituminaria* (closely related to Rydberg's *Pediomelum*) it seems most appropriate to include all these plants into an umbrella genus for the time being.

3. Recently the inflorescences of Psoraleeae have been shown to be pseudoracemes (Tucker, 1987a); a distinct type of inflorescence.

4. The discoloration at the tip of the keel is a dense purple blotch and is confined to the inner epidermal layer. Preliminary chromatographic analysis of petal flavonols and flavonoids show the highest concentrations of these chemicals in this region (Stirton & Zantovska, unpublished, research conducted in the Biochemistry Laboratory at the Kirstenbosch Botanical Gardens, November 1986). This blotching is highly characteristic of the tribe. Keel tip blotching does occur occasionally in other tribes but from our early tests would not appear to be either positionally or chemically homologous. Other genera tested were *Podalyria*, *Virgilia*, *Trifolium* and *Coronilla*. They produced quite different chromatographic profiles which would suggest that this feature is homoplasious in the Papilionoideae.

5. Pseudomonadelphy is now known from a number of species.

6. The pollen data provided here are incorrect and should be amended as in Chapter 7.2. The published data refer to the tribe Amorpheae.

7. The stigma is now known to be capitate as well as penicillate.

8. After further detailed work on the genera *Psoralea* and *Hallia* I can no longer accept that *Hallia* is a distinct genus and include it here as a new subgenus in *Psoralea* based on the presence of subepidermal glands, retention of first metaphyll leaf as adult leaves, high concentrations of proanthocyanidins and deep purple colouration of flowers.

Psoralea **L. subgenus** *Hallia* **(Thunb.) C.H. Stirton, comb. nov.**

4 species of remote, high altitude localities, I have studied all of these species in the field. The new species are illustrated and presented in Appendix 2. I have also included in Appendix 2 a representative selection of plates from described as well as little known species so as to enable the reader to compare this genus with the plates of *Otholobium* included in the main text.

14. A detailed study of *Otholobium* has increased the number of species from an estimated 20 to 53. This includes 16 new species which are described in chapter 9.

15. Grimes (fide determinavit labels on loan specimens returned to K in 1987) has indicated that he will be segregating the genus *Orbexilum* s.l. into a number of genera much along the lines of Rydberg (1919-1920; 1928), describing the predominantly South and Central American species as the new genus *Rupertia*.

16. Petals "blue"; in reality these are various shades of mauve through purple to violet. Pure white flowers occur in *P. oreopola* C.H. Stirton ined., yellowish-green flowers in *P. glaucescens* Eckl. & Zeyh. and blackish purple in *P. repens* Berg.

17. The background to the decision adopted here to accept *Psoralea pinnata* as the lectotype of *Psoralea* has been discussed in Stirton, Field, Brummitt and McNeill (1981; See Appendix 3). This paper, and the discussion it generated at the International Botanical Conference in Sydney, resulted in the establishment of a Specialist Committee for the investigation of the principles of lectotypification. The committee, of which I was a member from its inception until my resignation in October, 1985 (I continued as a non-voting member thereafter) reported to the recent 1987 Conference in Berlin (McNeill, 1986). Unfortunately most of the Committee's proposals were rejected (Brummitt, pers. comm. 1987) and referred once more to a new specialist committee. Clearly this is a very complex area of nomenclature which, however it is finally arbitrated, will have serious

nomenclatural repercussions for a number of genera as indicated by McNeill, Odell, Consaul and Katz (1987) and Zijlstra (1986). The latter author argues in favour of the residual method, which if adopted, would require that *Psoralea* become *Ruteria* Medik. and the type of the genus *Psoralea* would be *P. americana*. The problem with Zijlstra's comments (p. 860, second para.) is that he does not realize that *Psoralea* s.l. is now accepted as comprising a number of very distinct genera. The residue method would, if applied in his sense, require at least 100 name changes. He is correct though in realizing that Stirton *et al.* (1981) were incorrect in saying that Medikus (Vorles, II: 381, 1787) could not have have retained *P. glandulosa* L. in *Psoralea* as it was described by Linnaeus in 1763. This would leave *P. americana* as the type of *Psoralea*. I shall be preparing a detailed conservation proposal in 1989 to retain the genus *Psoralea* sensu *P. pinnata* L.

18. *Psoralea (Orbexilum* s.l.) *glandulosa* will be referred to the genus *Rupertia* Grimes.

19. As discussed in Point 13 I now accept this genus as a subgenus of *Psoralea*. The necessary new combinations have been made in Stirton (1984). See Appendix 4.

20. The majority of the new combinations in this new genus were published in Stirton (1985a). See Appendix 5.

21. The genus *Cullen* has not been revised since my circumscription in this paper. I have had correspondence with Drs. J.H. Ross, L. Pedley and A. Lee, all of Australia and all of whom had considered revising it but who decided against it for various reasons, the major and understandable ones being the complex variation found in the genus in Australia and the poor state of collecting from some critical areas. For these reasons I decided against making the new combinations implicit in my fragmentation of the genus. However, Dr. B.V. Verdcourt, Kew, has decided to make the necessary combinations for

the Papua New Guinean region (Verdcourt, in press). The new combinations for African representatives of *Cullen* were made in Stirton (1981a). See Appendix 6.

22. The new combinations in the genus *Bituminaria* have been made in Stirton (1981a). See Appendix 6.

1.3 **Relationship of Psoraleeae and Amorpheae**

The tribes Psoraleeae and Amorpheae were for a long period of their existence united variously into a single tribe. Table 1.2 summarises the differences between them as currently accepted.

1.4 **History of *Psoralea* s.l. in Africa south of the Sahara**

The genus *Psoralea* was created by Linnaeus (Sp. Pl. 763, 1753) to accommodate a number of diverse legumes, from three continents, which shared a common feature of embedded glands. Only two of his seven species were from Africa south of the Sahara; *P. aculeata* L. and *P. pinnata* L. In the chronological survey presented below of the brief history of African Psoraleas I have placed in parentheses the currently accepted name. No parentheses indicates that the name is still acceptable.

Bergius (1767) added two new species to *Psoralea*: *P. decidua* Berg. [*P. aculeata* L.] and *P. repens* Berg. The next species of *Psoralea* to be discovered was 32 years later and was recognized initially as *Anthylis ensifolia* Houttyn. It was only in 1938 that Merrill realized that this taxon was in fact the earliest name for *P. capitata* L.f. [*P. ensifolia* (Houttyn) Merrill].

Table 1.2 Distribution of the genera of the tribes Daleae Hutch., Amorpheae (Boiss.) Barneby, Psoralieae (Benth.) Hutch., Psoraleae (Benth.) Rydberg and Psoraleeae (Benth.) Stirton.

GENUS	AUTHORS				
	Rydberg (1919)[1]	Rydberg (1928)[2]	Hutchinson (1964)[3]	Barneby (1977)[4]	Stirton (1981)[5]
Amorpha	P	P	P	A	
Apoplanesia	P	P	P	A	
Asphalthium	P	P	P		
Bituminaria					P
Cullen	P	P	P		P
Dalea			D	A	
Errazurizia				A	
Eysenhardtia	P	P	P	A	
Hallia		P	P		P
Hoita	P	P	P		
Kuhnistera	P	P	D		
Marina			P	A	
Meladenia			P		
Orbexilum	P	P	P		P
Otholobium					P
Parosela	P	P			
Parryella	P	P	P		
Pediomelum	P	P	P		
Petalostemon	P	P	D		
Psoralea	P	P	P		P
Psoralidium	P	P	P		
Psorobatus	P	P	P		
Psorodendron	P	P	P		
Psorothamnus	P	P	P	A	
Rhytidomene	P	P	P		
Thornbera	P	P	D		

[1,2] P = Psoraleae. [3] P = Psoralieae, D = Daleae. [4] A = Amorpheae. [5] P = Psoraleeae.

DIFFERENCES BETWEEN PSORALEEAE AND AMORPHEAE

AMORPHEAE	PSORALEEAE
1. Determinate branching	1. Indeterminate branching
2. Diarch root structure	2. Tetrarch root structure
3. Basic chromosome No. x=10	3. Basic chromosome no. x=11
4. Subepidermal secretory cavities, hollow	4. Epidermal trabeculate secretory cavities
5. Predominantly anomocytic stomata	5. Predominantly paracytic stomata
6. Epistemonous petals	6. Free petals
7. Astragaloid root nodules	7. Desmodioid root nodules
8. No 6AH pterocarpan chemistry	8. 6AH pterocarpan chemistry

Linnaeus filius (1781) described 5 new Cape species: *P. rotundifolia* L.f [(*Otholobium rotundifolium* (L.f.) C.H. Stirton], *P. axillaris* L.f., *P. stachydis* L.f. [(*Otholobium hirtum* (L.) C.H. Stirton], *P. laevigata* L.f. and *P. capitata* L.f. [*Psoralea ensifolia* (Houtt.) Merrill].

Poiret (1794) added a few more species to *Psoralea*: *P. acuminata* Poir. [*O. acuminatum* (Poir.) C.H. Stirton]; *P. astragalina* Poir. [*P. ensifolia* (Houtt.) Merrill]; *P. ononoides* Lam. [*O. virgatum* (Burm.f.) C.H. Stirton]; *P. sericea* Poir. [*O. sericeum* (Poir.) C.H. Stirton; this species was later published by Ker-Gawler under the name *P. pedunculata* Ker-Gawler]. Jacquin (1797), another French botanist who published a number of beautiful colour plates of *Psoralea* in Hortus Schoenbrunnensis, added three new species: *P. multicaulis* Jacq. [*P. ensifolia* (Houttyn) Merrill]; *P. odoratissima* Jacq. and *P. angustifolia* Jacq. [*P. verrucosa* Willd.].

In 1819 Sims published a colour plate and description of the distinctive, tree-like *P. arborea* (a name which was neglected until recently).

The next revision of *Psoralea* was by Thunberg (1823) in which he dealt with 20 Cape species, describing 8 new species: *P. linearis* Thunb. [*P. axillaris* L.f.]; *P. mucronata* Thunb. [*P. aculeata* L.]; *P. triflora* Thunb. [Application of this name is still uncertain]; *P. tomentosa* Thunb. [*O. sericeum* (Poir.) C.H. Stirton]; *P. racemosa* Thunb. [*O. racemosum* (Thunb.) C.H. Stirton]; *P. involucrata* Thunb. [*Melolobium involucratum* (Thunb.) C.H. Stirton]; *P. argentea* Thunb. [*O. argenteum* (Thunb.) C.H. Stirton] and *P. striatum* Thunb. [*O. striatum* (Thunb.) C.H. Stirton]. Thunberg referred to the small herbaceous Psoraleas as the new genus *Hallia* (Thunberg, 1799) describing 5 new species: *Hallia alata* Thunb.; *H. flaccida* Thunb. [*P. plauta* C.H. Stirton]; and *H. virgata* Thunb. [*P. laxa* Salter]. He also made the following new combinations: *H. cordata* (Thunb.) Thunb. [based on his *Hedysarum cordatum* Thunb., now *P. monophylla* (Thunb.) C.H. Stirton];

H. asarina (Thunb.) Thunb. [based on *Crotalaria asarina* Berg., now *P. asarina* (Berg) Salter]; and *H. imbricata* (L.f.) Thunb. [*P. imbricatum* (L.f.) Salter].

De Candolle's (1825) revision of *Psoralea* which dealt with 61 species was the first comprehensive account of the genus across its natural distribution range. This revision was also to fix the inflorescence as the predominant character on which all subsequent infrageneric divisions were to be based. De Candolle dealt with 31 southern African species, describing *P. fascicularis* DC. and *P. obtusifolia* DC. [*Cullen obtusifolia* (DC.) C.H. Stirton] as new. He also described *Hallia angustifolia* [*P. laxa* Salter].

After De Candolle there were two almost simultaneous revisions of Cape Psoraleas (See Meissner, 1843 for a discussion on the merits of each). The first was that of Ecklon and Zeyher (1836) followed in a few months by Meyer (1836).

Ecklon & Zeyher (1836) recognized 45 species of Cape Psoraleas and 7 species of Hallias. The Psoraleas were divided into six groups based on leaf type, number and shape; the first departure from infrageneric classifications based on inflorescence structure. Except for the misplacement of *P. aculeata* L. in their group 7 and the inclusion in their group 8 of their two new species *P. plicaefolia* and *P. exigua* [*Cullen obtusifolia* (DC.) C.H. Stirton] this is a remarkably natural classification, at least in modern generic terms or groupings. 22 new species and 13 new varieties were described: *P. affinis* Eckl. & Zeyh.; *P. albicans* Eckl. & Zeyh. [*O. argenteum* (Thunb.) C.H. Stirton]; *P. algoensis* Eckl. & Zeyh. [*O. bracteolatum* (Eckl. & Zeyh.) C.H. Stirton]; *P. bracteolata* Eckl. & Zeyh. [*O. bracteolatum* (Eckl. & Zeyh.) C.H. Stirton]; *P. candicans* Eckl. & Zeyh. [*O. candicans* (Eckl. & Zeyh.) C.H. Stirton]; *P. cephalotes* Eckl. & Zeyh. [*O. stachyerum* (Eckl. & Zeyh.) C.H. Stirton]; *P. diffusa* Eckl. & Zeyh. [*P. repens* Berg.]; *P. exigua* Eckl. & Zeyh. [*Cullen obtusifolia* (DC.) C.H. Stirton]; *P. filifolia* Eckl. & Zeyh.; *P. glaucescens* Eckl. & Zeyh.; *P. hilaris* Eckl. & Zeyh. [*O. racemosum* (Thunb.) C.H. Stirton]; *P. jac-*

quiniana Eckl. & Zeyh. [*P. aphylla* L.]; *P. oligophylla* Eckl. & Zeyh.; *P. polyphylla* Eckl. & Zeyh. [*O. polyphyllum* (Eckl. & Zeyh.) C.H. Stirton]; *P. plicaefolia* Eckl. & Zeyh. [*Cullen obtusifolia* (DC.) C.H. Stirton]; *P. rupicola* Eckl. & Zeyh. [*O. striatum* (Thunb.) C.H. Stirton]; *P. restioides* Eckl. & Zeyh.; *P. speciosa* Eckl. & Zeyh.; *P. stachyerum* Eckl. & Zeyh. [*O. stachyerum* (Eckl. & Zeyh.) C.H. Stirton]; *P. thunbergiana* Eckl. & Zeyh.; *P. uncinata* Eckl. & Zeyh. [*O. uncinatum* (Eckl. & Zeyh.) C.H. Stirton]; and *P. venusta* Eckl. & Zeyh. [*O. venustum* (Eckl. & Zeyh.) C.H. Stirton]. Of these names only 9 are synonyms.

It was unfortunate, as Meissner (1843) stated tersely in his introduction, that Ecklon & Zeyher's Enumeratio (1836) predated Meyer's Commentario (1836) by a few months as Meyer was the superior taxonomist. Nonetheless, many of Meyer's names, based mostly on Drege collections, still survive (See Marshall, 1937). His first paper (Meyer, 1832) dealt with 14 species and described one new species, *Psoralea obliqua* E. Mey. [*Otholobium obliquum* (E. Mey.) C.H. Stirton], and two new varieties of *P. bracteata* L. (var. *bracteata* and var. *brevibracteata* [the former is *O. fruticans* (L.) C.H. Stirton and the latter *O. bracteolatum* (Eckl. & Zeyh.) C.H. Stirton]. In his Commentario Meyer (1836) dealt with 29 species describing nine new species: *P. carnea* E. Mey. [*O. carneum* (E. Mey.) C.H. Stirton]; *P. cephalotes* E. Mey [*O. stachyerum* (Eckl. & Zeyh.) C.H. Stirton], *P. densa* E. Mey. [*O. acuminatum* (Poir.) C.H. Stirton]; *P. glabra* E. Mey.; *P. obliqua* E. Mey. [*O. obliquum* (E. Mey.) C.H. Stirton]; *P. parviflora* E. Mey. [*O. parviflorum* (E. Mey.) C.H. Stirton]; *P. spathulata* E. Mey. [*O. mundianum* (Eckl. & Zeyh.) C.H. Stirton]; *P. tenuissima* E. Mey. and *P. triantha* E. Mey. [*O. trianthum* (E. Mey.) C.H. Stirton] and *P. velutina* E. Mey. [Type unknown, identity uncertain].

Three years later Bertoloni added two new species based on cultivated material: *P. altissima* Bertol. and *P. conferta* Bertol. - both synonyms of *P. pinnata* L. (Bertoloni, 1839).

The various strands of *Psoralea* taxonomy were drawn together by Walpers (1842). He recognized four groups based on inflorescences:

1, Floribus axillaribus sparsis;

2, Floribus apice ramorum confertis;

3, Spicis racemis umbellisve; and

4, Dubiae.

This classification has the same mixture of genera as did Harvey's (1862).

Meissner (1843), in a study based on Krauss collections from South Africa, recognised both *Hallia* (1 sp.) and *Psoralea* (10 spp.) and described two new species: *P. kraussiana* Meisn. and *P. harveyana* [*P. aculeata* L.]. I have not seen the types of these two species but *P. kraussiana* is probably synonymous with *P. pinnata* L. I know of no other species from Table Mountain near Cape Town which would match the protologue. However, it is possible that this locality could be a reference to Table Mountain, near Pietermaritzburg, in Natal. I will need to see the types before I can be sure.

The major work on the genus *Psoralea* in South Africa is Harvey's treatment in Flora Capensis (Harvey, 1862). His overview of legumes in this volume is remarkably perspicacious, especially when one considers the lack of material he had to deal with and the limited exploration of the time, particularly of eastern parts. It is also clearly the work of an experienced field botanist. Harvey recognized 41 species and 11 varieties. His seven new species were: *P. biflora*, **P. bowieana*, *P. glaucina*, *P. gueinzii*, **P. hamata*, **P. macradenia*, **P. polysticta* Benth. ex Harv. and **P. thomii*. All these species, except *P. biflora* [(*Coelidium biovulatum* (Harv.) Granby)], are still valid today. The starred species have been transferred to *Otholobium* (Stirton, 1985a, Appendix 5).

Harvey (1862) divided the genus *Psoralea* into 5 sections, based on features of the inflorescence: Sparsiflorae, Fasciculatae, Racemosae, Spicatae, and Pedunculares. Unfortunately these five groups show a mixture of genera: Sparsiflorae (*Psoralea* & *Otholobium*); Fasciculatae (*Psoralea* & *Otholobium*); Racemosae (*Otholobium*); Spicatae (*Otholobium*); and Pedunculares (*Otholobium*, *Cullen* and *Coelidium*). I have decided to delay infrageneric grouping in *Psoralea* and *Otholobium* until I have obtained more ontogenetic data and have completed my monograph of *Psoralea*. Grimes (1988) has recently lectotypified the various infrageneric taxa of Psoraleeae proposed by G. Don. in his *Hortus Britannicus* (1830) and by Taubert in Engler's *Die Natürlichen Familien*. Unfortunately he did not realize that Harvey (1862) had already proposed the sections *Sparsiflorae* and *Fasciculatae*. The nomenclature of infrageneric categories will need to be re-evaluated in the Psoraleeae in due course.

Psoralea foliosa Oliv. was the next African species to be described (Oliver, 1885). A variety of *P. foliosa*, var. *gazense* Bak.f., was described 16 years later by Baker (1911). Both these taxa have been transferred to *Otholobium*; var. *gazense* being raised to specific rank (Stirton, this revision). Next a small cryptic Cape species, *P. oreophila* Schlecht. was described by Schlechter in 1897, followed two years later by a second species from the easternmost parts of the range, *P. wilmsii* Harms (Harms, 1899).

The most recent overall assessment of psoraleoid legumes in South Africa is by Forbes (1930). Her concept of *Psoralea* is taken directly from Phillips (1926) and includes the genera *Cullen* pro parte, *Otholobium* and *Psoralea*, but not *Hallia* which she did not refer to. Neither types nor literature were cited and herbarium specimens were studied from only five herbaria (BOL, GRA, NH, PRE, SAM) compared to the 33 herbaria consulted in this study. She recognized 49 species, three of which were new: *P. keetii* Schonl. ex Forbes; *P. bolusii* Forbes [*Otholobium bolusii* (Forbes) C.H. Stirton] and *P. royffei* Forbes (reduced here to synonymy under *O. caffrum* (Eckl. & Zeyh.) C.H.

Stirton). Her two new species were unicates and have been accepted as types. *P. patersoniae* Schonl., an adventive early this century in South Africa but no longer, has been reduced to synonymy under *Cullen corylifolia* (L.) Medik. (Stirton, 1981a).

The Psoraleas of eastern southern Africa were revised briefly by Burtt Davy (1932). He recognized eight species describing one new species *Psoralea holubii* Burtt Davy [(*Cullen holubii* (Burtt Davy) C.H. Stirton]. In the same year Fourcade described the southern Cape species *P. heterosepalum* Fourc. [*O. heterosepalum* (Fourc.) C.H. Stirton].

Salter (1939) decided that the genus *Hallia* should be incorporated in *Psoralea* s.l.: *P. alata* (Thunb.) Salter; *P. asarina* (Berg.) Salter; *P. cordata* (L.) Salter [(now *P. monophylla* (L.) C.H. Stirton)]; *P. imbricata* (L.f.) Salter and *P. laxa* Salter. At first I did not agree with his decision (Stirton, 1981b) but have decided since that he was correct, but for different reasons (Chapter 1). *Hallia*, for example, shares with *Psoralea* the synapomorphies of a cupulate organ subtending the flowers, similar seedlings and similar essential oils.

Adamson and Salter (1950) provided a key and short descriptions to 19 species from the Cape Peninsula. Their generic concept included *Psoralea*, *Hallia* and *Otholobium*. They resuscitated *P. fruticans* and included the five Hallias (*P. alata*, *P. laxa*, *P. cordata*, *P. asarina* and *P. imbricata*).

In 1981 I described the new genus *Otholobium* C.H. Stirton based on *Psoralea caffra* Eckl. & Zeyh. (Stirton, 1981b; Chapter 1.2). The new combinations were made in 1984 (Stirton, 1984; Appendix 5). I have also described five new species of southern African Psoraleeae since 1981: *Otholobium pungens* C.H. Stirton (Stirton, 1982; Appendix 7); *O. rubicundum* C.H. Stirton and *O. pictum* C.H. Stirton (Stirton, 1983a; Appendix

9); *Psoralea trullata* C.H. Stirton and *P. implexa* C.H. Stirton (Stirton, 1983b; Appendix 10). A new combination and two new names required for the transfer of three species from *Hallia* to *Psoralea* were made in Stirton (1984; Appendix 11); *P. monophylla* (L.) C.H. Stirton; *P. plauta* C.H. Stirton and *P. cataracta* C.H. Stirton. 17 new species of *Psoralea* will be sent to press shortly (Plates only are exhibited in Appendix 2). These plates should assist the reader in evaluating my segregation of *Otholobium* from *Psoralea*.

1.5 **Scope of the study**

This study catalogues the discovery, description and nature of *Otholobium* in Africa. It forms part of an ongoing investigation of Psoraleeae worldwide. Unfortunately, our knowledge about generic limits is still incomplete, with many species misplaced, so it has not been possible to evaluate generic relationships except in a cursory manner.

I have attempted to assess the conservation status of each African species in the tribe Psoraleeae, in what I believe is a unique way, and wish thereby to show that the comparative morphological approach still has a real role to play in applied systematics generally. Nonetheless, where information was available I have utilized it in delimiting genera and species. This data is presented and discussed under the following chapter headings: cytology, phytogeography, palynology, morphology, anatomy, phytochemistry and conservation biology.

The main part of the thesis is a monographic account of the known species of *Otholobium*.

CHAPTER 2

MORPHOLOGY

2.1 Introduction

The genus *Psoralea* s.l. has been classified traditionally using gross morphological characters. I have extended and re-defined the use of many of these characters and have also used micromorphological, anatomical and chemical characters, especially in my analysis of generic relationships in Chapter 4.

It has not been possible to use anatomical characters as much as I would have liked either because other workers were already surveying particular features or organs (Grimes - floral anatomy; Turner - leaf anatomy; Tucker - floral ontogeny) or because there was not enough material to completely survey the genus. The first two studies are now partly published (Grimes, 1986; Turner, 1986) and the third will be submitted to press shortly (Tucker & Stirton, 1989). The chemical (Boardley, Stirton & Harborne, 1986) and palynological data (Ferguson, Furness & Stirton, 1989; Furness in Stirton, 1989) proved not to be very significant at the species level but were very useful at the generic and tribal levels. I have incorporated these data where appropriate.

The characters discussed in this chapter refer to two different operations; firstly, for the production of analytical keys and descriptions, and secondly for the estimation of phylogenetic relationships of Psoraleoid genera.

2.2. Characters used for key-making, computerized online identification and plant descriptions

The characters discussed in the next few sections are those employed in both the cladistic analysis of the genera and for key-making. The character set used for key-making is somewhat different to those used in the phylogenetic analyses and I will comment on the differences wherever appropriate.

Table 2.1 (Ascii file on Disk 1) is the initial list of characters considered for use in revising the genus *Otholobium*. To read this file load the disk in either a 360K or 1,2 Mb floppy disk drive and Type **LIST CHARS3**. Press return, then view the file using page up and page down keys, T for top of file and B for bottom of file, ESC to leave file; ? provides a help menu. This LIST program, a public-domain program written by Vernon Buergm, is provided for ease of viewing the disk files. I have also included some of the public-domain programs I used when running Delta. Not included are David Brayford's (Commonwealth Mycological Institute; Vers.1.1, 1987) DELTA EDITOR which is still under development and NORTON'S UTILITIES vers. 3. which is a licenced program.

The list in Table 2.1 has been reduced substantially during seven revisions. The current draft, which was used for the production of the various keys, is given in Table 2.2. These characters, and character states, are coded using Dallwitz's (1974, 1980) DELTA format (*Description Language for Taxonomy*). I have used the microcomputer version 21-Sept-1987 of CONFOR (courtesy of L. Watson) in running the data as well as the third edition of the User's Guide (Dallwitz & Paine, 1986) for DELTA.

My first experiences with the DELTA package were very frustrating as I was unable to resolve a number of installation problems and CONFOR errors, mostly relating

Table 2.2 List of characters in DELTA format used in final key-making.

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*SHOW: The genus *Otholobium* - (Psoraleeae, Papilionoideae) - characters.

*COMMENT: revised 8th August, 1987.

*CHARACTER LIST

```
1.01  #1. <habit of plant>/
1.02      1. small trees/
1.03      2. large shrubs <more than 1 m tall>/
1.04      3. small shrubs <less than 1 m tall>/
1.05      4. herbs/

2.01  #2. <height>/
2.02      cm tall/

3.01  #3. <regeneration after fires>/
3.02      1. coppicing after burns/
3.03      2. not coppicing after burns/

4.01  #4. <aggregation of individuals>/
4.02      1. colonial/
4.03      2. occurring as isolated individuals/

5.01  #5. <clumping habit>/
5.02      1. forming dense clumps/
5.03      2. never forming dense clumps <implicit>/

6.01  #6. <type of root system>/
6.02      1. lignotuber with spreading underground stems/
6.03      2. simple woody rootstock <implicit>/

7.01  #7. stems <habit>/
7.02      1. prostrate/
7.03      2. decumbent <sprawling>/
7.04      3. semi-erect to ascending/
7.05      4. erect/

8.01  #8. stems <number>/
8.02      1. solitary <one>/
8.03      2. few to many <more than one>/

9.01  #9. stems <duration>/
9.02      1. herbaceous/
9.03      2. woody only at base/
9.04      3. woody throughout/

10.01 #10. stems <point at which branching occurs>/
10.02     1. branching at the base/
10.03     2. branching in lower parts <from just above the base to the
10.04        middle>/
10.05     3. branching in upper parts <from the middle upwards>/
10.06     4. branching all along the stem/

11.01 #11. branches vestiture <canescence>/
11.02     1. comprised of white or silvery hairs/
11.03     2. comprised of brown, yellowish or blackish hairs <never
11.04        canescent, implicit>/

12.01 #12. branches <glandulosity>/
12.02     1. pustulate <covered in distinct warts or raised pustules>/
12.03     2. non-pustulate <warts or pustules absent or occasional, then flattened>/

13.01 #13. leaves <number of leaflets>/
13.02     1. unifoliolate <simple>/
13.03     2. 3-foliolate <implicit>/

14.01 #14. leaves <presence of rhachis if trifoliolate>/
14.02     1. digitately trifoliolate/
14.03     2. pinnately trifoliolate/
```

15.01 #15. leaves <orientation of leaves>/
15.02 1. clasping the shoots/
15.03 2. erect/
15.04 3. patent <spreading>/

16.01 #16. terminal leaflets <length>/
16.02 mm long/

17.01 #17. terminal leaflets <width>/
17.02 mm wide/

18.01 #18. leaves <leaf shape>/
18.02 1. very narrowly obovate/
18.03 2. narrowly obovate/
18.04 3. obovate/
18.05 4. broadly obovate/
18.06 5. very broadly obovate/
18.07 6. depressed obovate/
18.08 7. narrowly elliptic/
18.09 8. elliptic/
18.10 9. broadly elliptic/
18.11 10. circular <very broadly elliptic>/
18.12 11. transversely broadly elliptic/
18.13 12. linear/
18.14 13. narrowly oblong/
18.15 14. oblong/
18.16 15. narrowly ovate/
18.17 16. ovate/
18.18 17. broadly ovate/
18.19 18. very broadly ovate/
18.20 19. oblanceolate/

19.01 #19. leaves <folding>/
19.02 1. conduplicate/
19.03 2. partly conduplicate/
19.04 3. displayed <open>/

20.01 #20. leaves <degree of petiolation>/
20.02 1. subsessile <less than 2mm>/
20.03 2. petiolate <more than 2mm>/

21.01 #21. apex of terminal leaflets/
21.02 1. rounded/
21.03 2. obtuse/
21.04 3. retuse/
21.05 4. emarginate/
21.06 5. acute/
21.07 6. acuminate/
21.08 7. attenuate/

22.01 #22. base of terminal leaflets/
22.02 1. cordate/
22.03 2. rounded/
22.04 3. obtuse/
22.05 4. acute/
22.06 5. cuneate/

23.01 #23. mucro of terminal leaflets/
23.02 1. straight/
23.03 2. arching to patent/
23.04 3. recurved/

24.01 #24. mucro of terminal leaflets <robustness>/
24.02 1. setiferous <slender>/
24.03 2. thickened <implicit>/

25.01 #25. glands <visibility of glands on upper surface of terminal leaflet in dried state>/
25.02 1. visible with a x10 hand lens/
25.03 2. not visible with a x10 hand lens/

26.01 #26. glands <colour in dried state>/
26.02 1. black/
26.03 2. yellow, orange or hyaline/

27.01 #27. glands <density of upper surface vs. lower surface>/
27.02 1. more dense on upper surface/
27.03 2. more or less equal in number on both surfaces/
27.04 3. more dense on lower surface/

28.01 #28. glands <height above surface>/

28.02 1. distinctly raised above the surface/
28.03 2. impressed <flush with the surface>/

29.01 #29. lateral leaflets <symmetry>/
29.02 1. symmetrical <implicit>/
29.03 2. asymmetrical/

30.01 #30. lateral leaflets <length relative to the terminal leaflet>/
30.02 1. up to half the length of the terminal leaflet/
30.03 2. half to two thirds the length of the terminal leaflet/
30.04 3. about the same length as the terminal leaflet/

31.01 #31. lateral leaflets <width ratio of halves of lower surface>/
31.02 1. left half wider/
31.03 2. right half wider/

32.01 #32. immature leaves <vestiture on blade, excludes margins>/
32.02 1. glabrous/
32.03 2. hairy/

33.01 #33. lower surface of mature leaflets <vestiture>/
33.02 1. glabrous/
33.03 2. glabrescent/
33.04 3. minutely scabridous/
33.05 4. finely pubescent/
33.06 5. sparsely sericeous/
33.07 6. densely sericeous/
33.08 7. canescent/
33.09 8. pilose/

34.01 #34. petioles <length>/
34.02 mm long/

35.01 #35. petioles <length relative to length of terminal leaflets>/
35.02 1. shorter than terminal leaflets/
35.03 2. about equal in length to terminal leaflet/
35.04 3. longer than terminal leaflets/

36.01 #36. stipules <persistence>/
36.02 1. persistent/
36.03 2. caducous/

37.01 #37. stipules <length>/
37.02 mm long/

38.01 #38. stipules <length relative to petioles>/
38.02 1. shorter than petioles/
38.03 2. equal in length to petioles/
38.04 3. longer than petioles/

39.01 #39. stipules <shape of stipules>/
39.02 1. subulate/
39.03 2. linear <setaceous>/
39.04 3. lanceolate/
39.05 4. narrowly triangular/
39.06 5. broadly obliquely ovate/

40.01 #40. stipules <orientation relative to axis of shoot>/
40.02 1. clasping <appressed>/
40.03 2. patent/
40.04 3. recurved/

41.01 #41. stipules <vestiture>/
41.02 1. glabrous/
41.03 2. hairy/

42.01 #42. inflorescences <congestion of flowers inflorescences>/
42.02 1. lax <rachis visible between clusters of triplets>/
42.03 2. congested <flowers packed tightly, rachis not visible>/

43.01 #43. inflorescences <number of triplets of flowers in inflorescence>/
43.02 number of triplets per inflorescence/

44.01 #44. flowers <floral maturation>/
44.02 1. maturing more or less simultaneously/
44.03 2. maturing sequentially/

45.01 #45. flowers <length>/
45.02 mm long/

46.01 #46. flowers <colour>/
46.02 1. cream/
46.03 2. white/
46.04 3. pink/
46.05 4. mauve/
46.06 5. purple/
46.07 6. pale violet/
46.08 7. reddish violet/
46.09 8. yellow/

47.01 #47. apex of inflorescence <length relative to subtending leaves>/
47.02 1. overtopped by subtending leaves/
47.03 2. about equal in length to subtending leaves/
47.04 3. overtopping subtending leaves/

48.01 #48. flowers <occurrence of pedicels>/
48.02 1. pedicellate <greater than 1mm long>/
48.03 2. sessile <less than 1mm long>/

49.01 #49. pedicels <length>/
49.02 mm long/

50.01 #50. triplet bracts <persistence at anthesis>/
50.02 1. persistent/
50.03 2. caducous/

51.01 #51. triplet bracts <apex>/
51.02 1. multi-toothed <toothed>/
51.03 2. single-toothed <implicit, always with a single point>/

52.01 #52. flower bracts <persistence at anthesis>/
52.02 1. persistent/
52.03 2. absent/

53.01 #53. flower bracts <shape>/
53.02 1. linear/
53.03 2. lanceolate/
53.04 3. triangular/
53.05 4. ovate/

54.01 #54. bracteoles <occurrence>/
54.02 1. present/
54.03 2. absent/

55.01 #55. bracteoles <shape>/
55.02 1. filiform/
55.03 2. lanceolate/

56.01 #56. bracteoles <point of attachment>/
56.02 1. attached to pedicels/
56.03 2. attached to base of calyx tube/

57.01 #57. calyx tube <length>/
57.02 mm long/

58.01 #58. calyx tube <length relative to lateral and vexillar teeth>/
58.02 1. calyx tube shorter than calyx teeth/
58.03 2. calyx tube equal in length to calyx teeth/
58.04 3. calyx tube longer than calyx teeth/

59.01 #59. the vexillar calyx teeth <curvature>/
59.02 1. straight/
59.03 2. falcate/

60.01 #60. the carinal calyx teeth <apex>/
60.02 1. acute/
60.03 2. acuminate/
60.04 3. pungent/

61.01 #61. the carinal calyx teeth <width relative to other four teeth>/
61.02 1. narrower than other four teeth/
61.03 2. about equal in width to other four teeth/
61.04 3. broader than other four teeth/

62.01 #62. the vexillar calyx lobes <fusion above the tube>/
62.02 1. fused above the tube/
62.03 2. free above the tube/

63.01 #63. the vexillar calyx lobes <degree of fusion above the tube>/
63.02 1. fused for up to one third their length above the tube/

63.03 2. fused for one third to one half their length/
63.04 3. fused for more than half their length above the tube/

64.01 #64. calyx <length relative to flower length>/
64.02 1. shorter than corolla <implicit>/
64.03 2. about equal in length to corolla/
64.04 3. longer than the corolla/

65.01 #65. calyx <accrescent in fruit>/
65.02 1. accrescent in fruit/
65.03 2. same size in fruit/

66.01 #66. inner face of calyx <reticulation>/
66.02 1. prominently reticulate/
66.03 2. not prominently reticulate <implicit>/

67.01 #67. calyx glands <distribution>/
67.02 1. equally distributed on tube and teeth/
67.03 2. more densely concentrated on the teeth/

68.01 #68. calyx glands <size variation>/
68.02 1. constant in size/
68.03 2. variable in size/

69.01 #69. standard petal <length>/
69.02 mm long/

70.01 #70. standard petal <width>/
70.02 mm wide/

71.01 #71. standard petal <shape>/
71.02 1. narrowly elliptic/
71.03 2. elliptic/
71.04 3. broadly elliptic/
71.05 4. orbicular/
71.06 5. narrowly ovate/
71.07 6. ovate/
71.08 7. broadly ovate/
71.09 8. very broadly ovate/
71.10 9. narrowly obovate/
71.11 10. obovate/
71.12 11. broadly obovate/
71.13 12. oblong/

72.01 #72. standard petal <occurrence of auricles>/
72.02 1. auricles prominent/
72.03 2. auricles weakly developed/
72.04 3. auricles absent/

73.01 #73. apex of standard petal/
73.02 1. rounded/
73.03 2. obtuse/
73.04 3. emarginate/
73.05 4. retuse/
73.06 5. broadly emarginate/

74.01 #74. claw of standard petal/
74.02 1. short and broad/
74.03 2. elongated and narrow/

75.01 #75. wing petals <length>/
75.02 mm long/

76.01 #76. wing petals <length of wing petals relative to keel petals>/
76.02 1. shorter than keel petals/
76.03 2. equal in length to keel petals/
76.04 3. longer than keel petals <implicit>/

77.01 #77. filament of vexillar stamen/
77.02 1. free from androecial sheath/
77.03 2. fused to androecial sheath along its lower third/
77.04 3. fused to androecial sheath for half or more of its length/

78.01 #78. the androecial sheath <fusion of filaments>/
78.02 1. split adaxially along its entire length/
78.03 2. fused basally, free distally/
78.04 3. free basally, fused distally/

79.01 #79. androecial fenestrae <presence>/
79.02 1. present/

79.03 2. absent/

80.01 #80. pistil <length>/
80.02 mm long/

81.01 #81. ovary <vestiture>/
81.02 1. hairy/
81.03 2. glabrous/

82.01 #82. ovary <presence of club-shaped glands>/
82.02 1. club-shaped glands present/
82.03 2. club-shaped glands absent/

83.01 #83. ovary <presence of a stipe>/
83.02 1. sessile/
83.03 2. stipitate <raised on a flange of upright tissue or stalked>/

84.01 #84. style <presence of hairs between ovary and entasis>/
84.02 1. hairy/
84.03 2. glabrous/

85.01 #85. entasis <position along the style>/
85.02 1. broadest before the point of flexure/
85.03 2. broadest at point of flexure/
85.04 3. broadest beyond point of flexure/

86.01 #86. stigma <vestiture>/
86.02 1. penicillate <implicit>/
86.03 2. not penicillate/

87.01 #87. fruits <length>/
87.02 mm long/

88.01 #88. fruits <enclosure within calyx>/
88.02 1. enclosed by calyx at maturity/
88.03 2. partly protruding from calyx at maturity <less than half>/
88.04 3. mostly protruding from calyx at maturity <more than half>/

89.01 #89. fruits <texture>/
89.02 1. papery <implicit>/
89.03 2. cartilaginous/

90.01 #90. fruits <reticulation>/
90.02 1. distinctly reticulate/
90.03 2. reticulation absent, scarcely defined or obscured by hairs/

91.01 #91. seeds <length>/
91.02 mm long/

92.01 #92. seeds <mottling>/
92.02 1. mottled/
92.03 2. uniformly coloured <implicit>/

93.01 #93. seeds <basic colour>/
93.02 1. light brown/
93.03 2. dark brown/
93.04 3. chestnut brown/
93.05 4. khaki/
93.06 5. olive-green/
93.07 6. black <occasionally reddish black>/

94.01 #94. <African distribution>/
94.02 1. Kenya/
94.03 2. Tanzania/
94.04 3. Malawi/
94.05 4. Mozambique/
94.06 5. Swaziland/
94.07 6. Zimbabwe/
94.08 7. Lesotho/
94.09 8. South Africa <implicit>/

95.01 #95. <South African distribution>/
95.02 1. Natal/
95.03 2. Transvaal/
95.04 3. Cape Province <implicit>/
95.05 4. Orange Free State/

96.01 #96. apocolpia <type of pattern>/
96.02 1. smooth/
96.03 2. very finely reticulate/

96.04 3. finely reticulate/
96.05 4. reticulate/
96.06 5. coarsely reticulate/

97.01 #97. apocolpial cap <occurrence>/
97.02 1. present/
97.03 2. absent/

98.01 #98. mesocolpia <type of pattern>/
98.02 1. finely reticulate/
98.03 2. reticulate/
98.04 3. coarsely reticulate/
98.05 4. very coarsely reticulate/

99.01 #99. mesocolpia <course of reticulae>/
99.02 1. reticulae winding/
99.03 2. reticulae straight/

100.01 #100. colpal margins <length>/
100.02 1. short <do not reach the apocolpia>/
100.03 2. long <reach the apocolpia>/

101.01 #101. margo <occurrence>/
101.02 1. present/
101.03 2. absent/

102.01 #102. Pollen grain <shape, determined by P/E ratio, see Erdtman, 1952>/
102.02 1. oblate/
102.03 2. suboblate/
102.04 3. oblate spheroidal/
102.05 4. spheroidal/
102.06 5. prolate spheroidal/
102.07 6. subprolate/
102.08 7. prolate/

to using an "aberrant" word-processor to produce the data files. I subsequently learnt that a number of other people were making similar mistakes.

DELTA EDITOR, which I used to produce the CHARS, ITEMS and SPECS files for the Conservation Status descriptions (See Chapter 8) is written and compiled in Zorland (Zortech) C. It is considerably faster than using a word-processor to produce the data files and has some valuable error checking features. Unlike the files I produced for this chapter using Wordstar 2000 Plus, release 3 (WS2000), the DELTA EDITOR files ran error free first time. Most of the errors which arose when using WS2000 related to initially using document mode instead of non-document (ASCII) mode and to input errors (typographical errors, misplaced slashes, extra paragraph ends, omitted commas and tab stops). Such errors have a cumulative effect and soon produce large listings of error messages, especially if the error occurs at the beginning of a file. These errors are rather daunting for the novice working in isolation, especially as they are not documented in the manual.

2.2.1 **Scoring the characters**

The morphological characters described in this section were scored from dried herbarium material and spirit collections and then checked against fresh material cultivated either at the Royal Botanic Gardens, Kew or collected in the field. Herbarium material was reconstituted by soaking in boiled water; the measurements, which were somewhat smaller, were adjusted after a study of fresh material. Whenever possible, at least five specimens were scored for each species and were representative of as much of the taxon's range as possible.

Herbarium vouchers were collected of all plants studied in the field and are deposited in a large number of herbaria as indicated in the citations of specimens in the

taxonomic chapter. Approximately 1536 *Otholobium*, 1840 *Psoralea*, and 460 *Cullen* herbarium specimens were examined from 33 herbaria (AA, BM, BOL, BRUX, CN, E, G, GRA, GRAZ, HER, ISC, K, L, LINN, M, MO, NBG, NH, NU, NY, OXF, P, PRE, PRU, PRC, S, SAAS, SAM, STE, TUB, U, W, WAG). Standard abbreviations of Internationally recognised herbaria listed by Holmgren, Keuken & Schofield (1981) were used. In a number of cases I have not been able to study original types and have had to study microfiches or photographs. Fortunately there were no instances where this did not provide a satisfactory interpretation.

Most of the full plate black & white illustrations of each species were based at least in part on colour photographs or on spirit material. The aquarelles were painted by Ellaphie Ward-Hilhorst from live material (Vouchers in NBG).

2.2.2 **Gross character set**

The divergence in vegetative characters of the tribe Psoraleeae provides many parallels to those seen in other tribes of the Papilionoideae. For a discussion of this general phenomenon see Polhill (1976). As he points out the comparative morphology of vegetative parts is profitable but time consuming and prone to misinterpretation. The similarities found in vegetative parts may be strongly linked to the environment (Carlquist, 1978) and it often necessitates a detailed study of anatomy and micromorphology before one can interpret them meaningfully for phylogenetic studies. With these provisos in mind I have used vegetative features of *Otholobium* for the artificial keys, where they are particularly valuable, but have hardly used them at all for the phylogenetic analysis. Considerably more work is needed before they too can be used confidently in cladistic studies.

In thinking about vegetative variation one is reminded of Vavilov's (1922) **Law of Homologous Series in Variation** which relates to the parallel series of variability found, often with high predictability, in closely related taxa. Levyns (1934) has related this concept to the South African genus *Lobostemon*. Her conclusions are similar to mine so I will discuss this type of variability later when discussing the range of variability in some locally abundant, widespread species occurring in diverse habitats versus that of other species which are comprised of sparsely populated, narrowly-distributed colonies growing in specific habitats. These **wide** and **narrow** species provide the most difficult and easiest problems of morphological interpretation respectively.

2.2.2.1. **Vegetative characters**

2.2.2.1.1. **Habit**

88% of the species in the genus *Otholobium* are shrubby; a few species can also develop into small trees: *O. arborescens*, *O. striatum* and *O. spicatum*. There do not appear to be any perennial herbs or annuals in the genus.

As in the tribe Genisteae (Polhill, 1976) the shrubby species are essentially of two sorts; one group being an adaptation of the aerial parts to resist adverse environmental conditions such as fire and drought, the other developing large lignotubers and/or rhizomatous root systems which, often fire resistant, respond to favourable growing conditions very rapidly by producing many new stems very quickly. These species are referred to in the next section and in Chapter 8.

Stems may be solitary or many and may be either prostrate, decumbent, semi-erect to ascending, or erect. Some species are densely shrubby and much branched (*O.*

spissum, *O. incanum*, *O. lanceolatum*); others slender or virgate (*O. trianthum* and *O. arborescens*).

There are three main types of stem bark pattern occurring in the genus *Otholobium*. In pattern 1 (Fig. 2.1A) the bark is generally thin and distinctly green, smooth and with scattered linear lenticels lying parallel to the axis. Pattern 2 (Fig. 2.1B) also has greenish stems, but only where the bark has peeled away; lenticels not visible; the general appearance being one of broad longitudinal criss-crossing furrows. In pattern 3 (Fig. 2.1C) the bark is similar to Pattern 1 except that the lenticels are rather different, comprised of numerous rounded lenticels usually arranged in files. Similar patterns are found in *Psoralea*. The patterns appear to correlate broadly with habitat; types 1 and 2 in dry land sites and type 3 mainly in seepage areas. Detailed studies are in progress to determine if these differences are reflected anatomically and will be reported on in my monograph on *Psoralea*.

Young branches and seasonal shoots vary from densely canescent (*O. hirtum*, *O. incanum*, *O. striatum*, *O. sericeum*, *O. thomii*) to glabrescent and densely warty or pustulate (*O. accrescens*, *O. caffrum*, *O. hamatum*, and *O. lucens*).

An interesting feature of both genera in the drier parts of their respective ranges is their tendency to produce long extension shoots towards the end of the hottest, driest months (January - February) of summer. By the time the first rains arrive these shoots would usually have completed their maximum growth. After the rains have fallen the plants produce many short floriferous shoots, referred to here as **burst branching**, which rarely last the wet season and which in most plants will have sloughed off within two years. This phenomenon is particularly marked in *Otholobium argenteum*, *O. candicans*, *O. carneum*, *O. hirtum*, *O. macradenium*, *O. prodiens*, *Psoralea glaucescens*, *P. verrucosa*, *P. filifolia*, *P. oligophylla*, *P. sordida*, and *P. connixa*. This pattern is repeated in some

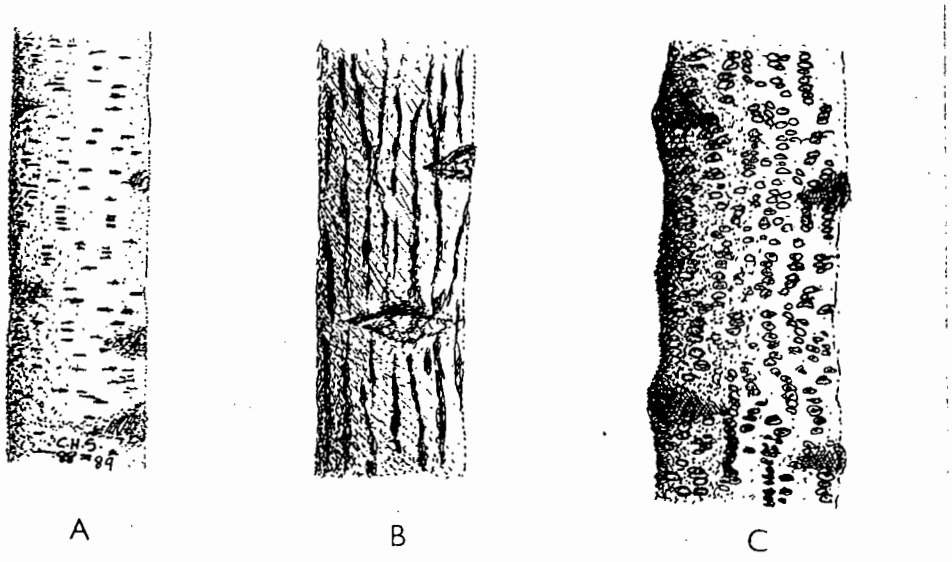

Fig. 2.1 Main stem bark patterns in *Otholobium* and *Psoralea*: A, Type 1, *Otholobium spicatum* (*Stirton* s.n., photograph); B, Type 2, *Psoralea aculeata* (*Stirton* s.n., photograph); C, Type 3, *P. pinnata* (Herbarium voucher *Stirton 11164*).

Otholobiums which grow in the summer-rainfall areas of the country: *O. nigricans*, *O. gazense*, and *O. polystictum*. This dry summer **burst-branching** suggests that the plants are now adapted to surviving in the drier areas but are still undergoing an annual rhythm indicative of a possibly previous summer rainfall distribution range. This phenomenon has been commented on by Levyns (1964) and Taylor (1978).

It has been traditionally thought that C_4 plants are better adapted than C_3 plants to hot, arid, high light environments such as rocky outcrops (Björkman, 1973; Black, 1973). Baskin & Baskin (1985) have suggested that the differences are not nearly as great as originally thought. Their study revealed that 95% of the 90 taxa endemic to unshaded rocky outcrop plant communities of unglaciated eastern USA use the C_3 pathway; showing that the C_4 pathway is not necessarily a requisite for adaptation to the hot, dry, high light environment of the rocky outcrops. Pearcy and Ehleringer (1984) concluded their comparative study of C_3 and C_4 ecophysiology by saying that the "*Photosynthetic pathway is only one of a suite of morphological, physiological and life history characteristics that determine success or failure of a taxon in a particular environment*".

A pertinent feature of many Psoraleas and Otholobiums is that they have intensely chlorophyllous, densely lenticelled stems. Baskin and Baskin (1985) reported that *Psoralea* (*Pediomelum subacaulis*) was a C_3 plant. No other records are available for Psoraleeae, although from an inspection of the numerous anatomical figures of Turner (1986) it is evident that this tribe does not possess Kranz anatomy. It would be interesting for ecophysiologists to determine the relationship of phenology of shoot extension and photosynthetic capacity in African Psoraleeae.

2.2.2.1.2. **Root Systems**

Very little is known about the root systems of Psoraleeae in general. Lignotubers and rhizomes occur in *Otholobium* and are recorded here for the first time. Nodulation is of the Desmodioid type and is discussed below.

(a) **Lignotubers**

A few taxa which at first inspection seem to be perennial herbs are slow growing shrubs with large lignotubers or underground rhizome systems (*O. lanceolatum*, *O. thomii*, *O. accrescens*, *O. rotundifolium*, *O. dreweae*, and *O. zeyheri*).

Apart from a passing comment by Kruger (1979, in his review of South African heathlands) of the existence of lignotubers in *Psoralea* spp. I can find no reference to the structure and behaviour of these root systems in African Psoraleeae. However, a recent review on the structure, function and ecological significance of burls and lignotubers in Mediterranean ecosystems is available (James, 1984).

Sprouting, the production of new stems and roots from protected tissue, is a common regenerative mode of woody plants often associated with Mediterranean type climates and frequent fires. Any destruction of the aerial canopy will remove apical dominance and result, within days, in a rapid extension of dormant buds formed at the base of the stem, (in a woody structure called a **lignotuber**) and is associated with carbohydrates and reserves necessary for their development (James, 1984). Lignotubers, therefore, are sites of dormant buds and act as food reservoirs (Carlquist, 1978).

The first comprehensive study of lignotubers was by Kerr (1925). In South Africa lignotuberous woody plants are frequent in the families Bruniaceae, Penaeaceae, Geissolomataceae, and Grubbiaceae and are present too in the Proteaceae, Ericaceae, and Rutaceae (See Table 1 in James, 1984). The anatomy of lignotubers has been studied in

a number of the endemic Cape families (Carlquist, 1975, 1977, 1978; Carlquist & DeBuhr, 1977). Keeley (1977) distinguishes between "**sprouters**" (plants with lignotubers, fire-resistant and facultative seeders) and "**seeders**" (fire-susceptible and obligate seeders). In reality there is probably a continuum from seed production to vegetative production. As Williams (1975) points out the relative importance of sexual and vegetative reproduction may be a compromise between fitness for the current environment and genetic flexibility for future environments.

There is some controversy about the relative age of species with lignotubers (**sprouters**) and whether possession of a lignotuber is a primitive or derived feature. Contrast the opposing arguments of Karschon (1971) with those of Burbidge (1960) concerning the occurrence of lignotubers in *Eucalyptus* - a case of ontogeny versus phylogenetic interpretations from phytogeography. According to Wells (1969) **sprouting** is an ancestral trait in woody dicotyledons, but as James (1984, p. 258) argues the possession of a lignotuber sometimes may be a highly derived condition. Other data need to be taken into consideration. It is not possible to say yet whether this feature is primitive or derived in Psoraleeae. More ecological data are needed.

(b) **Nodulation**

Root nodulation has been reported to occur in a number of Psoraleoid Leguminosae (Eriksson, 1873; Corby, 1980, 1981; Allen & Allen, 1981). As Corby (1981) points out nodule shape and its related features can be remarkably constant in Leguminosae, particularly in the Papilionoideae.

In a detailed study of 197 leguminous genera he distinguished and described 5 types of root nodules (Corby, 1980). He classified nodules in Psoraleeae as **desmodioid**. Such nodules have a determinate growth habit, are oblate with a narrow, non-girdling at-

tachment to the root, have monosomatic bacterioid tissue, and are commonly lenticelled with a spherical nodular meristem.

Desmodioid type nodules (Fig. 2.3) are characteristic of the tribes Psoraleeae, Desmodieae and Loteae and are often accompanied by "giant-like" or "massive" **mucunoid** type nodules. The **desmodioid** nodule also occurs in seven other tribes which he describes as **Dimorphic**, i.e. they have either of the two main types of nodules, determinate or indeterminate. **Desmodioid** nodules are common in the Dalbergieae and Phaseoleae and are often found in the Abreae, Sesbanieae and Tephrosieae. The tribes Dalbergieae and Phaseoleae have predominantly determinate nodules so might, with the tribes Desmodieae and Loteae, be considered as possible outgroups to the Psoraleeae for cladistic analysis. As Corby, Polhill & Sprent (1983) point out the Psoraleeae, Desmodieae, Indigoféreae and Phaseoleae are predominantly Old World genera which also share a thickening of the endexine in their pollen.

Additional experimental support comes for some of these tribes based on a paper by Wilson (1939) in which he shows that plantlets of *Orbexilum (Pediomelum) esculentum* were nodulated by rhizobia from *Caragana frutescens* (Galegeae), *Glycine max* (Phaseoleae), *Oxytropis lambertii* (Galegeae), *Phaseolus vulgaris* (Phaseoleae), *Stizolobium deeringianum* (Phaseoleae) and *Vicia villosa* (Vicieae). However, no reciprocal cross-innoculations were done so it is not possible to comment on the galegoid and vicioid taxa above which have different **astragaloid** and **crotalaroid** type nodules respectively. Kulkarni (cited by Allen *et al.*, 1981) was able to conclude from reciprocal cross-inoculations between *Vigna sinensis* and *Psoralea (Cullen) corylifolia* that *Psoralea* was part of the cowpea rhizobial conglomerate. The tribe Amorpheae, which has been traditionally allied with the Psoraleeae, has **astragaloid** type nodules.

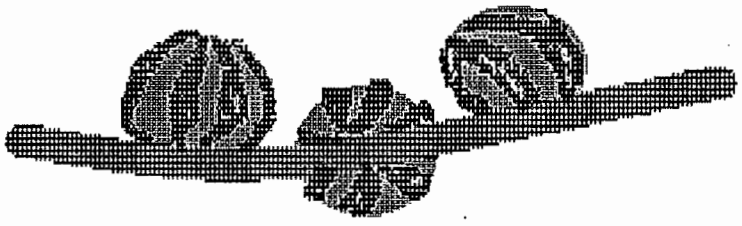

Fig. 2.3 Desmodioid nodules in *Otholobium accrescens* (*Stirton 11619*).

Root nodules have been recorded from the following genera and species in the Psoraleeae: *Bituminaria acaulis*, *B. bituminosa*; *Cullen (adscendens)*, *C. americanum*, *C. corylifolium*, *C. (eriantha)*, *C. obtusifolium*, *C. (patens)*; *Hoita orbicularis*; *Otholobium foliosum*, *O. candicans*, *O. decumbens*, *O. gazense*, *O. fruticans*, *O. rotundifolium*, *O. sericeum*, *O. wilmsii*; *Orbexilum onobrychis*, *O. lanceolatum*, *O. pedunculatum*, *O. simplex*; *Pediomelum esculentum*; *Psoralea aphylla*, *P. asarina (Hallia)*, *P. ensifolia*, *P. (Hallia) imbricata*, *P. (Hallia) laxa*, *P. (Hallia) monophylla*, *P. oligophylla*, *P. pinnata*, *P. restioides*; *Psoralidium argophyllum*, *P. floribundum*, *P. tenuiflorum*; *(Rupertia) macrostachya* (Erikson, 1873; Bolley, 1893; Naudin, 1897; Dawson, 1900; Alway & Pickney, 1909; Warren, 1909; Wilson, 1939; Appleman & Sears, 1943; Mostert, 1955; Bowen, 1956; Norris, 1959; Beadle, 1964; Grobbelaar, van Beijma & Todd, 1967; Grobbelaar & Clark, 1972; Corby, 1974, 1980).

To these can be added seven new records of South African species (Spirit material in Royal Botanical Gardens, Kew: K): *Otholobium accrescens* (*Stirton 11619*), *Psoralea affinis* (*Stirton 11621*), *P. arborea* (*Stirton 11175*), *P. ensifolia* (*Stirton 11623*), *P. oligophylla* (*Stirton 8219*), *P. triflora* (*Stirton 11622*), *P. verrucosa* (*Stirton 10199*). All of this material was obtained directly from the wild and all the nodules produced were typically **desmodioid**: spherical, determinate, oblate with banded lenticels. No "massive" nodules (sensu Corby, Polhill and Sprent, 1983) were present. However, none of the wild collected seed of 14 species from both genera germinated and grown on at the Royal Botanic Gardens, Kew produced any nodules, despite being cultivated in a greenhouse filled with diverse genera, from many tribes, including Desmodieae and Phaseoleae. Except for *O. spicatum*, *O. sericeum*, *O. stachyerum* and *Psoralea pinnata* none of the plants grew very well. All of these species, it might be added, are pioneer AWW plants (See Chapter 8; abundant locally, widespread and occupying many different habitats.)

2.2.2.1.3. **Seedlings**

The importance of seedlings as a source of diagnostic characters in plant taxonomy has been recognised since De Candolle (1825; who has provided one of the most detailed surveys yet). In some studies data from seedlings have been the basis for considerable re-arrangements of classifications (e.g. Lèonard, 1957). However, there has been some criticism of the guiding principles proposed by Gilbert & Lèonard (1954) and later used by Lèonard (1957) in his classic seedling study and subsequent re-arrangement of African Amherstioid and Detarioid legumes (Webberling & Leenhouts, 1966). The general consensus at present is that the importance of seedlings for taxonomic studies depends on the group under consideration and that Lèonard's principles have no general validity (See De Vogel, 1979 for a general discussion). Nevertheless, although the organs and characters of seedlings are limited in number, the number and specific combinations of morphological characteristics are large enough to have enabled the production of seedling keys to entire regional floras (Csapody, 1968; Muller, 1978).

The most comprehensive review of seedling morphology and structure in the Leguminosae is that of Compton (1912). Recent general reviews are those of De Vogel (1979), and Duke & Polhill (1981).

Based on the studies of Leguminous seedlings by Lèonard (1957), Duke (1965, 1969), and Ng (1975), Duke & Polhill distinguish 6 conditions which may be found in legume seedling patterns: 1, hypocotyl extension (yes/no); 2, cotyledon emergence from testa (yes, **phanero** / no, **crypto**); and 3, cotyledon emergence below (**hypogeal**), at (**geal**), or above (**epigeal**) ground level. To this can be added differentiation between seedling (**eophylls**) and mature (**metaphylls**) leaves. Scale leaves are referred to as **cataphylls** or **prophylls.**

De Vogel's (1979) classification (Fig. 2.2, Table 2.3) is based on combinations of characters which express mode of development. He recognises 7 types of seedling in the Leguminosae: 1. *Macaranga* type; 2a, *Sloanea* type / subtype; 2b, *Sloanea* type / *Palaquium* subtype; 6a, *Heliciopsis* type / subtype; *Horsefieldia* type / subtype; 11a, *Endertia* type /subtype; 11b, *Endertia* type / *Chisocheton* subtype; and 12, *Cynometra ramiflora* type. Type 12 only occurs in *Cynometra* in the Caesalpinioideae; type 6a is absent from the Mimosoideae; and type 11b is absent from the Caesalpinioideae. All of the Psoraleeae reported in this study belong to his 2a *Sloanea* type / subtype. From a phylogenetic viewpoint it is interesting that the 2a type of seedling is also dominant in the tribes Indigofereae, Desmodieae (See Ohashi, Figs. 4.1-13 & 5.1-5, 1973) and Dalbergieae. Perhaps of allied interest is Compton's (1912) finding that the roots of the tribes Indigofereae, Millettieae, Loteae, Desmodieae and Phaseoleae (Excl. *Erythrina*) all have a tetrarch structure whereas *Dalea* of the Amorpheae has a diarch structure.

Although useful in understanding seedling ecology De Vogel's classification is not regarded as being helpful in understanding legume patterns (Duke *et al.*, 1981). However, the use of seedling characters has been proved quite effective in assessing generic and tribal relationships in a number of legume groups, for example, Vassiliczenko (1937), Maekawa (1955), Léonard (1957), Lazaro (1966), Robbertse & van der Schijff (1975), Vassal (1972), Baudet (1974), Sastrapradja, Sastrapradja, Aminah & Lubis (1975), Kupicha (1977), and Lavin (1988), although few of these studies considered any anatomical features. The following studies have provided useful characters (McMurray & Fisk, 1936; Meijer Drees, 1941; Patel & Venkateswara, 1975; Couderc, 1979; Haque & Engleman, 1979; Bakale and Hadke, 1980; Hedge & Tilak, 1981; Ye, 1983; Pillai & Sharma, 1983). Nongonierma (1971) in a revision of the *Tephrosia purpurea* (L.) Pers. complex in West Africa has shown how valuable seedling characteristics can be at the specific level. Unfortunately very little attention has been given to variation within a species (Li, 1978). The phyllotaxis of legume seedlings has been studied by

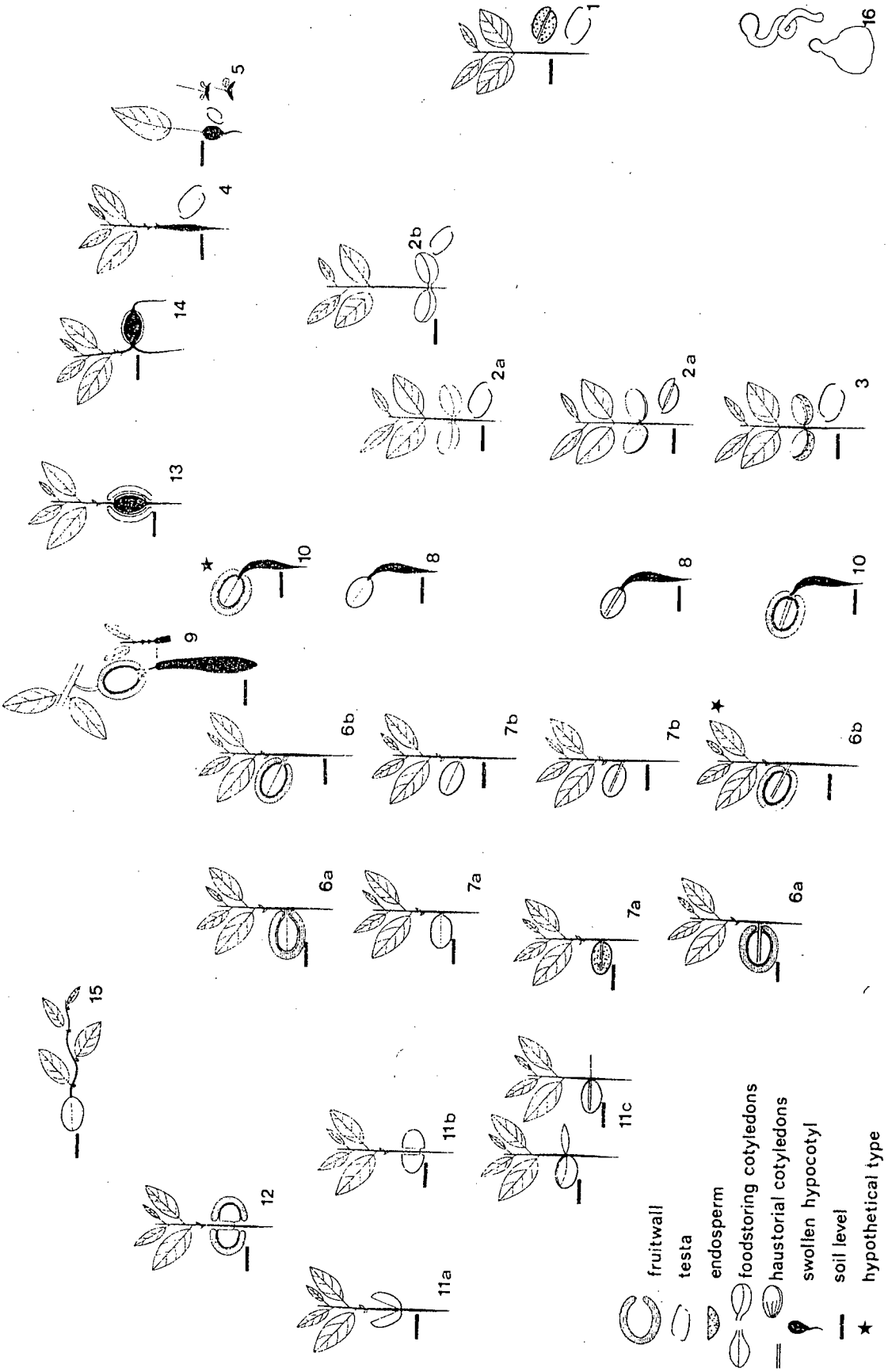

Fig. 2.2 Seedling classification proposed by de Vogel (1979), with illustrations of the different types. Model in which the recognised seedling types are arranged according to morphological similarities.

Table 2.3 Comparison of the proposed seedling types with former classifications of Dicotyledonous seedlings (From De Vogel, 1979).

Bokdam's classification	Duke's classification	Léonard's classification	Klebs' classification	Classical classification	Proposed classification
			Seedlings with one or both cotyledons rudimentary		Ternstroemia type (4)
				EPIGEAL SEEDLINGS in strict sense (Para) cotyledons free	Cyclamen type (5)
Cananga type Omphalocarpum type Argania type Asterales type	Phanerocotylar	Type I Type II Type III Type IV Type V	Type 1 Type 2 Type 3 Type 4 Type 5		Macaranga type (1)
Tieghemella type					Sloanea type/subtype (2a)
	? Phanerocotylar			EPIGEAL SEEDLINGS in broad sense (Para) cotyledons partly or entirely covered	Sterculia stipulata type (3)
	CRYPTOCOTYLAR				Blumeodendron type (8)
			Seedlings with one or both cotyledons rudimentary		Rhizophora type (9)
					Coscinium type (10)
Monodora type					Horsfieldia type/ Pseuduvaria subtype (7b)
					Heliciopsis type/ Koordersiodendron subtype (6b)
					Endertia type/subtype (11a)
	Suberyptocotylar			Epigeal sensu Léonard	Sloanea type/Palaquium subtype (2b)
	? Suberyptocotylar				Endertia type /Streblus subtype (11c)
	CRYPTOCOTYLAR	Type V	Cotyledons subterranean	HYPOGEAL SEEDLINGS	Endertia type/Chisocheton subtype (11b)
					Cynometra ramiflora type (12)
		Type VI, VII			Heliciopsis type/subtype (6a)
Butyrospermum type Pycnanthus type					Horsfieldia type/subtype (7a)
					Hodgsonia type (15)
			Seedlings with one or both cotyledons rudimentary		Barringtonia type (13)
					Garcinia type (14)
					Orobanche type (16)

Haccius (1940). Detailed investigations have been carried out on the anatomy of cotyledons (Smith 1981, 1983; Smith & Scott, 1985). Another suite of characters, which I was unable to record in this study, is provided by anthocyanin pigmentation (Nozolillo 1973; Nozolillo & McNeill, 1985).

Apart from a short report on *Psoralea subacaulis* (Baskin & Quarterman, 1970) and on a *Psoralea* sp. by Lubbock (1892) no data are available on the morphology or anatomy of seedlings of the tribe Psoraleeae. Table 2.4 lists the characters used in the analysis of seedling morphology. The following descriptions, produced using DELTA CONFOR TONAT (Dallwitz & Paine, 1986) summarise new data on the general morphology of seedlings of 13 species of African Psoraleeae; a key to the species studied is also provided. Voucher specimens are preserved as spirit material and are housed in the spirit collection of the Royal Botanic Gardens, Kew (K).

(a) *Otholobium*

O. bolusii (Forbes) C.H. Stirton

Hypocotyl 15 mm long. Cotyledons 10 mm long, 6,0 -- 6,3 mm wide. Epicotyl densely hairy, hairs patent; 18 mm long. Petiole 7 mm long, distinctly hairy. First eophylls 15 mm long, 10 mm wide at widest point, eglandular, elliptic, blade hairy on both sides; stipules 3 mm long. Second eophylls 3 -fid. Metaphyll 3 -fid. Voucher specimen: *Stirton 10052.*

O. hirtum (L.) C.H. Stirton

Hypocotyl 20 mm long. Cotyledons 13 mm long, 8 mm wide. Epicotyl densely hairy, hairs patent; 8 mm long. Petiole 10 mm long, distinctly hairy. First eophylls 14 mm long, 12 mm wide at widest point, glandular, broadly elliptic, blade hairy on both sides, margins ciliate; stipules 3 mm long. Second eophylls 3 -fid. Metaphyll 3 -fid. Voucher specimen: *Stirton 8425.*

Table 2.4 List of characters (in DELTA format, see text) used in the morphological analysis of seedlings of *Psoralea* and *Otholobium*.

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* SHOW: Seedling morphology of *Psoralea* and *Otholobium* (Psoraleeae).

* CHARACTER LIST

#1. Hypocotyl <length mm>/
mm long/

#2. Cotyledon <length>/
mm long/

#3. Cotyledon <width>/
mm wide/

#4. Epicotyl <degree of hairiness>/
1. glabrous/
2. sparsely hairy, hairs appressed/
3. densely hairy, hairs patent /

#5. Epicotyl <length>/
mm long/

#6. Stipule of first eophyll <length>/
mm long/

#7. Petiole <length>/
mm long/

#8. Petiole <hairiness>/
1. glabrous or with few scattered hairs/
2. distinctly hairy/

#9. First eophyll <length>/
mm long/

#10. First eophyll <width at widest point, mm>/
mm wide at widest point/

#11. First eophyll <occurrence of glands>/
1. glands present/
2. glands absent/

#12. First eophyll <shape>/
1. very broadly ovate/
2. broadly elliptic/
3. oblong/
4. ovate/
5. obovate/
6. elliptic/
7. narrowly ovate/

#13. First eophyll <glandularity>/
1. present/
2. absent/

#14. Second eophyll <number of leaflets>/

-fid/

#15. Metaphyll <number of leaflets>/
-fid/

#16. <Voucher specimen used in seedling studies>/

O. spicatum (L.) C.H. Stirton

Hypocotyl 25 -- 30 mm long. Cotyledons 8 -- 9 mm long; 4,5 mm wide. Epicotyl densely hairy, hairs patent; 20 mm long. Petiole 9 mm long, distinctly hairy. First eophylls 12,0 -- 12,5 mm long, 7 mm wide at widest point, glandular, obovate. Second eophylls 3 -fid. Metaphyll 3 -fid. Voucher specimen: *Stirton 8363.*

O. stachyerum (Eckl. & Zeyh.) C.H. Stirton

Hypocotyl 18 --- 22 mm long. Cotyledons 7 -- 8 mm long, 3,5 -- 4,5 mm wide. Epicotyl densely hairy, hairs patent; 10 -- 22 mm long. Petiole 5 -- 6 mm long, distinctly hairy. First eophylls 9,5 -- 11,0 mm long, 6 -- 7 mm wide at widest point, glandular, elliptic, blade hairy on both sides; stipules 1 mm long. Second eophylls 3 -fid. Metaphyll 3 -fid. Voucher specimens: *Stirton 9620, 9631.*

O. swartbergense C.H. Stirton

Hypocotyl 18 mm long. Cotyledons 12 mm long, 7 mm wide. Epicotyl densely hairy, hairs patent; 8 mm long. Petiole 9 mm long, distinctly hairy. First eophylls 12 mm long, 13 mm wide at widest point, glandular, very broadly ovate; stipules 3 mm long. Second eophylls 3 -fid. Metaphyll 3 -fid. Voucher specimen: *Stirton 10310.*

(b) *Psoralea*

P. sp. nov.

Hypocotyl 5 -- 6 mm long. Cotyledons 6,5 -- 8 mm long, 5 -- 6 mm wide. Epicotyl glabrous, 4,5 -- 5 mm long. Petiole 4 mm long, with a few scattered hairs. First eophylls 10 -- 11 mm long, 5 mm wide at widest point, glandular, elliptic; stipules 3,0 -- 3,5 mm long. Second eophylls 1 -fid. Metaphyll 1 -fid. Voucher specimen: *Stirton 8923.*

P. aculeata L.

Hypocotyl 5 -- 6 mm long. Cotyledons 14 -- 15 mm long, 6,0 -- 6,3 mm wide. Epicotyl glabrous, 8 -- 9 mm long. Petiole 9 mm long, glabrous. First eophylls 10 - 13 mm long, 5,5 -- 6,0 mm wide at widest point, glandular, elliptic; stipules 4 mm long. Second eophylls 3 -fid. Metaphyll 3 -fid. Voucher specimen: *Stirton 10027.*

P. affinis (Eckl.& Zeyh.) C.H. Stirton

Hypocotyl 20 -- 27 mm long. Cotyledons 13 -- 14 mm long, 5,0 -- 5,5 mm wide. Epicotyl glabrous, 11 -- 16 mm long. Petiole 12 mm long, with scattered appressed hairs. First eophylls 19 -- 22 mm long, 7,5 -- 8,0 mm wide at widest point, glandular, elliptic; stipules 5 mm long. Second eophylls 3 -fid. Metaphyll 5 -fid. Voucher specimen: *Stirton 9617.*

P. arborea (Sims) C.H. Stirton

Hypocotyl 20 mm long. Cotyledons 11,5 -- 12,0 mm long, 5-5,5 mm wide. Epicotyl sparsely hairy, hairs appressed; 8 mm long. Petiole 15 mm long, with a few scattered hairs. First eophylls 11 -- 13 mm long, 6 -- 7 mm wide at widest point, eglandular, elliptic; stipules 6,0 -- 6,5 mm long. Second eophylls 5 -fid. Metaphyll 5 -fid. Voucher specimen: *Stirton 9951.*

P. axillaris (L.f.) C.H. Stirton (Garcias Pass, tall tree form)

Hypocotyl 12 mm long. Cotyledons 19 mm long, 9 mm wide. Epicotyl sparsely hairy, hairs appressed; 19 mm long. Petiole 33 mm long, with a few scattered hairs. First eophylls 33 mm long, 14 mm wide at widest point, glandular, narrowly ovate; stipules 6 mm long. Second eophylls 6 -fid. Metaphyll 7-fid. Voucher specimen: *Stirton 10275.*

P. latifolia (Harv.) C.H. Stirton (Palm Beach form)

Hypocotyl 3 mm long. Cotyledons 9 -- 11 mm long, 4,0 -- 4,5 mm wide. Epicotyl glabrous, 20 -- 35 mm long. Petiole 12,0 -- 12,5 mm long, glabrous. First eophylls 11,0 -- 13,5 mm long, 6,5 mm wide at widest point, glandular, oblong; stipules 2 mm long. Second eophylls 3 -fid. Metaphyll 5 -fid. Voucher specimen: *Stirton 8093*.

P. latifolia (Harv.) C.H. Stirton (Izingolweni form)

Hypocotyl 14 mm long. Cotyledons 19 mm long, 7,5 -- 8,0 mm wide. Epicotyl glabrous, 15 mm long. Petiole 22 mm long, glabrous. First eophylls 23 mm long, 12 mm wide at widest point, glandular, narrowly ovate; stipules 3,5 mm long. Second eophylls 3 -fid. Metaphyll 5 -fid. Voucher specimen: *Stirton 10372*.

P. oligophylla (Eckl. & Zeyh.) C.H. Stirton

Hypocotyl 6 mm long. Cotyledons 10,0 -- 11,0 mm long, 5 mm wide. Epicotyl glabrous, 10 mm long. Petiole 15 mm long, glabrous. First eophylls 10 mm long, 6 mm wide at widest point, eglandular, elliptic; stipules 3 mm long. Second eophylls 3 -fid. Metaphyll 3 -fid. Voucher specimen: *Stirton 8219*.

Key to selected species of *Psoralea* and *Otholobium* based on seedlings.

KEY version: 21-SEP-87. Run at 16:00 on 06-DEC-87.

Characters - 16 in data, 14 included, 12 in key.

Items - 13 in data, 13 included, 14 in key.

RBASE = 2.00 ABASE = 2.00 REUSE = 1.10 VARYWT = 1.00

Characters included 1-12 14-15

Character reliabilities 1-2,7 3,5 4,9 5-6,7 7,6 8,8 9-10,7 11,9 12,6 14-15,9

1(0). Epicotyls glabrous to sparsely hairy, hairs appressed; petioles glabrous or with a few scattered hairs..... 2

Epicotyls densely hairy, hairs patent; petioles distinctly hairy..... 9

2(1). Metaphylls 1 -- 3-fid..... 3

Metaphylls 5 -- 7-fid..... 5

3(2). Glands present on first eophylls..... 4

Glands absent from first eophylls.....
..... Psoralea oligophylla (Eckl. & Zeyh.) C.H. Stirton

4(3). Hypocotyl densely warty; cotyledons 6,5 -- 8,0 mm long; petioles of first eophylls 4 -- 5 mm long; second eophylls and metaphyll 1-fid.....
..... Psoralea sp.

Hypocotyl smooth; cotyledons 14 -- 15 mm long; petioles of first eophylls 9 mm long; second eophylls and metaphyll 3-fid.....Psoralea aculeata L.

5(2). Second eophylls 3-fid..... 6

Second eophylls 5 -- 6-fid..... 8

6(5). First eophylls 11,0 -- 13,5 mm long; hypocotyl 2-3 mm long.....
..... Psoralea latifolia (Sims) C.H. Stirton (Palm Beach form)

First eophylls 19 -- 23 mm long; hypocotyl 14 -- 27 mm long.....7

7(6). First eophylls 7,5 -- 8,0 mm wide at widest point, elliptic; petiole of cotyledons 7 mm long; hypocotyl strongly ribbed.....
..... Psoralea affinis (Eckl.& Zeyh.) C.H. Stirton

First eophylls 12 mm wide at widest point, narrowly ovate; petiole of cotyledons 10 --12 mm long; hypocotyl weakly ribbed.....
..... Psoralea latifolia (Harv.) C.H. Stirton

8(5). Second eophyll 6-fid, metaphyll 7-fid; first eophylls narrowly ovate, densely and minutely glandular; hypocotyl up to 12 mm long, 2 mm thick; cotyledons 19 mm long, 9 mm wide..... Psoralea axillaris (L.f.) C.H. Stirton

Second eophyll 5-fid, metaphyll 5-fid; first eophylls elliptic, eglandular; hypocotyl 20 mm long, 2,0 -- 2,5 mm thick; cotyledons 11,5 -- 12.0 mm long, 5,0 -5,5 mm wide..... Psoralea arborea (Sims) C.H. Stirton

9(1). Glands present on first eophylls..... . 10

Glands absent from first eophylls. Otholobium bolusii (Forbes) C.H. Stirton

10(9). First eophylls up to 9 mm wide at widest point; cotyledons up to 5 mm wide..... 11

First eophylls 9 -- 14 mm wide at widest point; cotyledons 5 mm wide or more..... 12

11(10). First eophylls obovate..... Otholobium spicatum (L.) C.H. Stirton

First eophylls elliptic.....

..... Otholobium stachyerum (Eckl. & Zeyh.) C.H. Stirton

12(10). First eophylls very broadly ovate... Otholobium swartbergense C.H. Stirton

First eophylls broadly elliptic..... Otholobium hirtum (L.) C.H. Stirton

The genera *Psoralea* and *Otholobium* may be distinguished on the basis of their general seedling morphology (Fig. 2.4). In *Otholobium* the epicotyl is weakly ribbed or smooth and always distinctly patently hairy whereas in *Psoralea* it is usually strongly ribbed, glabrous or sometimes sparsely semi- to appressedly hairy. The hypocotyl is much thicker in *Psoralea*. The first eophyll may be either glandular or eglandular in both genera. Only one, as yet unnamed, species (*Stirton 8923*), has a warty or pustulate epicotyl and a warty first eophyll petiole.

A character which could be very useful in phylogenetic studies is the foliolation sequence found in both genera (cotyledon -- first eophyll -- second eophyll -- first metaphyll). The following sequences have been found so far (numbers refer to the foliolation): *Otholobium* - only one pattern { 1-1-3-3 }; *Psoralea* - five patterns { 1-1-1-1; 1-1-3-3; 1-1-3-5; 1-1-5-5; and 1-1-6-7 with 1-1-3-5 being the commonest }. Based on these patterns and on general observations of leaf variation in Psoraleeae it is apparent that some of the dwarf shrubs and perennial herbs, of *Psoralea* in particular, may be neotenous species. Examples would appear to be *O. lanceolatum*, *O. accrescens*, *O. rotundifolium*, *Psoralea oreophila* and most of subgenus *Hallia* in *Psoralea*.

The seedling of *Psoralea oligophylla* {1-1-3-3} shows an interesting change from a digitately trifoliolate second eophyll to a pinnately trifoliolate first metaphyll. The subsequent metaphylls undergo a gradual loss of the laterals until only a unifoliolate leaf is produced in flowering brachyblasts. The reduction in foliolation from a pinnate condition appears to have occurred more than once in *Psoralea*, reducing in some instances to scales (e.g. *P. fleta*, *P. filifolia*, *P. rigidula*, *P. restioides*, *P. pullata*, *P. aphylla*, *P. connixa* and *P. peratica*). Most of these species have been "lost" under *P. aphylla*. However, observations of seedlings and young plants in the field indicated that the pattern of leaflet reductions are different in the taxa of this species complex and that once their status has been adequately documented will be found to be distinct morphological species.

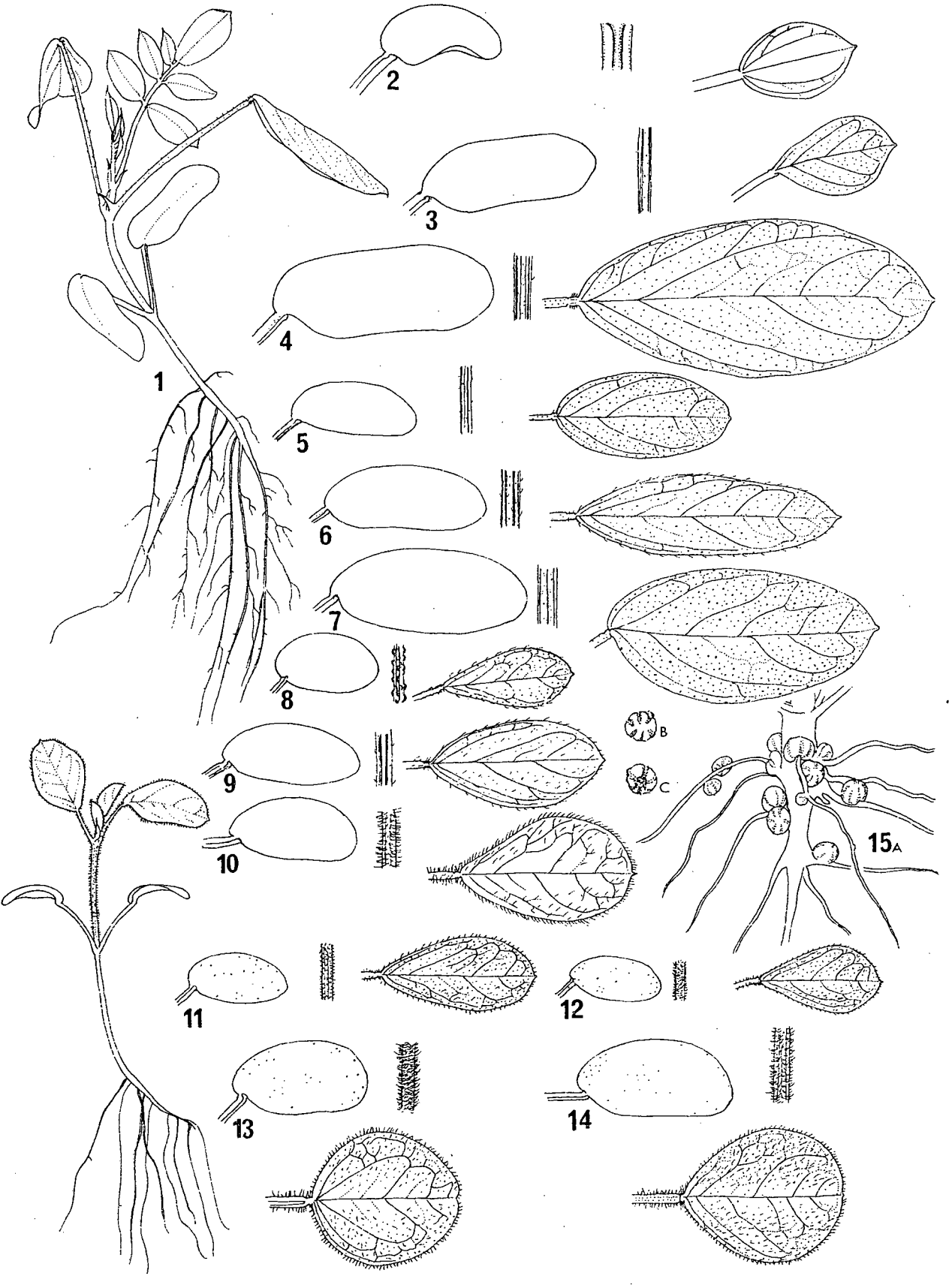


Fig. 2.4 General morphology of seedlings of South African representatives of *Psoralea* and *Otholobium*. Vouchers - A, *Psoralea*: seedling of *P. axillaris* (*Stirton 10275*), x1; 2, *P. oligophylla* (*Stirton 8219*); 3, *aculeata* (*Stirton 10027*); 4, *P. axillaris* (*Stirton 10275*); 5, *P. latifolia* (*Stirton 8093*); 6, *P.affinis* (*Stirton 9617*); 7, *P. latifolia* (*Stirton 10372*); 8, *P.* sp. nov. (*Stirton 8923*); 9, *P. arborea* (*Stirton 9951*). B, *Otholobium*: 10, *O. bolusii* (*Stirton 10052*); 11, *O. spicatum* (*Stirton 8363*), 12, *O. stachyerum* (*Stirton 9631*); 13, *O. swartbergense* (*Stirton 10310*); 14, *O. hirtum* (*Stirton 8425*); 15a, basal portion of seedling of *P. axillaris* (*Stirton 11621*) showing root nodules; 15b, distal end of nodule from point of attachment, 15c, proximal end of nodule; 16, seedling of *O. bolusii* (*Stirton 10052*). Figs. 1 & 16, x1; 2-14, x2; 15, x3.

The seedlings of *Otholobium* and *Psoralea* share a number of features in common: epigeal germination; paired, exstipulate, petiolate, opposite, asymmetrical, thickened cotyledons; distinct hypocotyl and epicotyl; paired, stipulate, opposite, simple, foliaceous first eophylls; and a changing phyllotaxis from opposite to alternate after the first eophyll which is decussate relative to the cotyledons. Descriptions of seedlings in the two genera are given below:

(a) *Otholobium*

Germination epigeal. *Hypocotyl* 15 -- 30 mm long. *Cotyledons* two, opposite, 8 -- 13 mm long, 3,5 -- 8,0 mm wide, elliptic to elliptic-oblong, base asymmetrical, texture thick; petiole 7 -- 11 mm long, channelled. *Epicotyl* 8 -- 20 mm long, vestiture present, patent, dense, fine to shaggy; petiole 5 -- 10 mm long, channelled. *First eophylls* opposite, 9,5 -- 14 mm long, 7 -- 13 mm wide; apiculate; petiole 5 -- 10 mm long, broadly and shallowly channelled, hairy, elliptic to broadly elliptic, obovate, or very broadly ovate, finely and evenly glandular except in *O. bolusii*, margin ciliate, venation distinctly brochidodromous; stipules present, 1 -- 3 mm long, straight, subulate. *Second eophyll* 3-fid, phyllotaxis hereafter alternate. *First metaphyll* 3-fid.

(b) *Psoralea*

Germination epigeal. *Hypocotyl* 3 -- 27 mm long. *Cotyledons* two, opposite, 6,5 -- 19 mm long, 4 -- 9 mm wide, elliptic to elliptic-oblong, base asymmetrical, texture thick; apiculate; petiole 7 -- 12 mm long, channelled. *Epicotyl* 4,5 -- 35,0 mm long, glabrous to very sparsely hairy with semi-patent hairs; petiole 4,0 -- 12,5 (30) mm long, channelled. *First eophylls* opposite, 10 -- 13 mm (30) long, 5 -- 8 (14) mm wide; petiole 4 -- 15 (22) mm long, narrowly channelled, glabrous or sparsely hairy, elliptic, narrowly ovate, or

oblong, densely and evenly glandular but eglandular in *P. arborea* and *P. oligophylla*, margin rarely sparsely ciliate, venation indistinctly brochidodromous; stipules present, (2) 3,5 -- 6,5 mm long, linear, falcate. *Second eophyll* 1-3-5-6-fid, phyllotaxis hereafter alternate. *First metaphyll* 1-3-5-7-fid.

2.2.2.2. **Reproductive structures**

2.2.2.2.1. **Inflorescence Structure**

Inflorescence structure in the Leguminosae is a much neglected character and has been used by relatively few workers; usually to assess relationships above the species level. The most notable studies are those of Rohrbach (1870), Sousa & Pena de Sousa (1981), Geesink (1984), Poncy (1986), Tucker (1987a), and Webberling (1988).

The classification of inflorescence structure is both difficult and controversial. The influence of Troll (1964, 1969) dominates the European approach and owes much of its current popularity to Webberling who has developed and expanded Troll's typological system (much of his data expanded from Troll's extensive unpublished manuscripts). Apart from Webberling one other worker is having an important impact on the study of legume inflorescences. Tucker (1987a, 1987b) has adopted a different terminology and in many aspects does not agree with Webberling's interpretations. However, I will refer to both worker's published work in my brief survey of Psoraleeae inflorescences.

Racemes and compound racemes (panicles) characterize the majority of the 22,000 species of the Leguminosae (Tucker, 1987a). Notable exceptions are the presence in some groups of "pseudoracemes" and cymes.

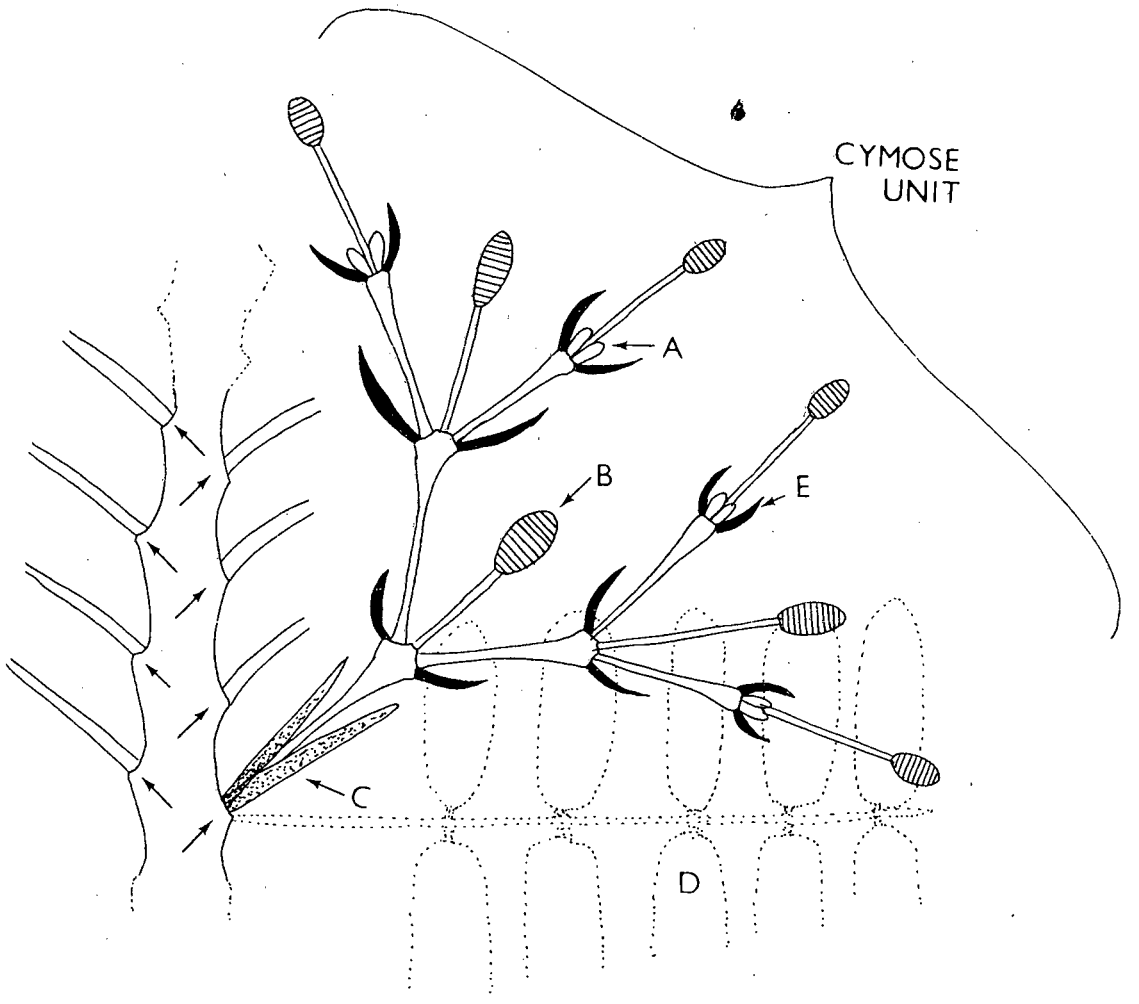


Fig. 2.5 Portion of a cymose inflorescence of *Poeppigia procera* Presl. (*Lewis 1338*, Kew spirit collection). A, Paired lateral buds; these do not develop; B, Terminal central flower; C, Paired prophylls; D, Leaf subtending the unit florescence; E, Paired bracts.

Racemes have a helical phyllotaxy of bracts, each of which subtends a flower; with floral initiation acropetal in an inflorescence. Spikes and umbels (*Otholobium swartbergense* and *O. sericeum*) are modified racemes scarcely distinguishable in young stages and are much less common. Cymes are extremely rare in the family but interestingly enough are to be found in *Psoralea*; they are considered by Tucker (1987b) to be probably derived. An example of a cyme, *Poeppigia procera* Presl. (*Lewis 1338*, K spirit collection number 48756) is given in Fig. 2.5.

The term **pseudoraceme** is defined by Tucker (1987a) to refer to inflorescences in which each first order bract on the primary axis subtends three flowers or as a panicle with short shoots in the axils, i.e. a compound inflorescence technically a panicle. This type of inflorescence has recently been shown by Tucker (1987a) to be a homologous feature unifying the tribes Abreaeae, Desmodieae, Millettieae (incl. Lonchocarpinae), Phaseoleae and Psoraleeae.

In Webberling's terms the basic type of inflorescence in Leguminosae is a heterothetic double (or multiple) raceme (Pleiobotryum) sensu Troll. His basic concepts and terminology are given in Webberling (1983, 1988). Figure 2.6 summarises his basic terminology. The whole flowering structure is called a **synflorescence** and is divided into three zones: a dormant basal **innovation zone**; an intermediate **inhibition zone** and an apical **enrichment zone**. The terminal florescence is called a **main florescence**. If other florescence bearing shoots arise from the axils below the basal internode these are referred to as **paracladia** or **repeating branches**. The florescences terminating the paracladia are termed **coflorescences**. Each paracladium can be preceded by a zone which bears second or higher order paracladia and second or higher order coflorescences. Spikes are transformed from racemes by a failure of pedicels to develop. If this is accompanied by a failure of the main axis to elongate then "umbellation" results. Also pertinent to his ideas is a clear distinction between the first (**alpha prophyll**) and second

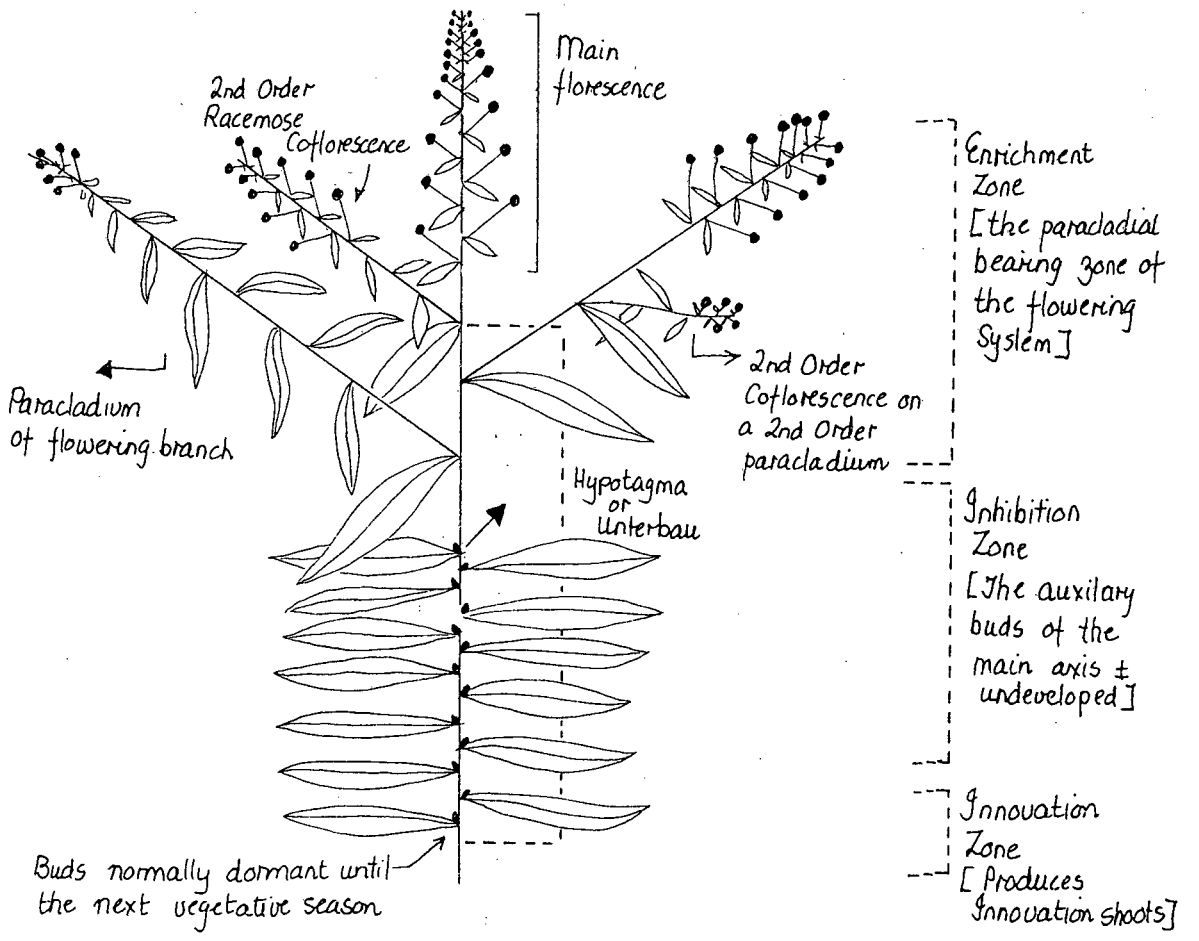


Fig. 2.6 Generalized diagram of a polytelic synflorescence based on Webberling (1988).

(**beta prophyll**) subtending leaves (**prophylls**) of a branch. The first internode of the branch, the one preceding the first prophyll, is called a **hypopodium**; the internode between the prophylls a **mesopodium**; and finally the one following the prophylls an **epipodium.**

According to Webberling the majority of legume inflorescences are **polytelic** (main axis does not end in a terminal flower) which suggests to him that they were derived from a **monotelic** inflorescence in which the main axis ends in a flower. Tucker (1987a) refers to these as **indeterminate** and **determinate** inflorescences respectively and distinguishes them further by saying that the definition should include termination *"by an organ or a flower; the terminal apical meristem is no longer present"*.

Two of the characters used by Barneby (1977) to segregate the Amorpheae from the Psoraleeae were the ontogeny of the branching patterns and position of the inflorescence in relation to their axis of origin; determinate, cymose and centrifugal in Amorpheae and indeterminate, racemose and acropetal in the Psoraleeae. The differences between the two tribes are elegantly described by Barneby (1977) as follows:

> "In the genus *Psoralea*, whether limited to its Old World representatives (as envisaged by Hutchinson) or expanded to include the New World segregates *Pediomelum* Rydb., *Orbexilum* Raf., *Psoralidium* Rydb., *Hoita* Rydb., etc., every spike or raceme (the latter sometimes reduced to a fascicle or a single flower) arises laterally from a leaf-axil along the axis of origin, which is capable, at least theoretically, of indefinite growth even though it may terminate, in practice, after giving rise to a single peduncle. In Amorpheae, as I would redefine the tribe, each spike or raceme terminates its axis of origin, any apparent continuation of the stem beyond a given peduncle

being in reality an axillary shoot. When the first axillary shoot is suppressed, the stem becomes simple and monocephalous. More often, however, such axillary shoots are developed and are in turn, either once or repeatedly, stopped by an inflorescence, and when this occurs all but the last inflorescence appears leaf-opposed. The growth of the stem in Amorpheae is determinate, the arrangement of inflorescences cymose and centrifugal; in Psoraleeae the growth of the stem is indeterminate, the arrangement of the inflorescences racemose and acropetal. The simple axillary position of the psoraleoid inflorescence differs essentially not at all from one genus to the next; the arrangements in Amorpheae, on the other hand are subject to relatively complex modification. In *Dalea* itself the individual spike or raceme occasionally appears axillary when actually terminating a leafless axillary branchlet, but the latter is identified as such and distinguished from a genuine peduncle by the presence of at least one stipular nodule at some point beneath the first flower. In *Eysenhardtia*, *Amorpha*, and *Dalea leucostachya* Gray the inflorescences are gathered (often or always) into a terminal leafless panicle of racemes or spikes, of which the central one always reaches anthesis first and thereby identified as the terminus of the initial stem-axis, the lateral racemes being in reality terminal to reduced, leafless branchlets axillary to bracts, sometimes again ramified. In *Apoplanesia* the whole inflorescence is a leafless or remotely and irregularly leafy panicle of racemes like that of *Amorpha* but with this difference, that some racemes issue, paired with a branchlet, directly from the axil of a bract or leaf. These pseudoaxillary racemes, always interposed between a leaf or bract and a branchlet, belong to the branchlet and represent its first terminus. They are sessile due to

> suppression of the antecedent internode, the paired branchlet itself arising from the same node as the raceme and surpassing it in common daleoid fashion. Whatever form the whole inflorescence of Amorpheae may take, the genera have this feature in common that the first inflorescence to reach anthesis is morphologically terminal to the stem that bears it; it may become (as often) simply and directly terminal, or the first member of an irregular monochasial series, or central to a cymosely forking, whole or partial panicle."

In Psoraleeae the branching system is such that two types of shoots are produced: **macroblasts** - a main axis with long internodes - which bears lateral shoots with short internodes (**brachyblasts**). Flower production is nearly always restricted to the brachyblasts which originate from the leaf axils of an "**overseasonal shoot**" (previous year's long shoot) or from a "**seasonal shoot**" (current season's long shoot). The leaves subtending macroblasts are usually considerably larger than those produced by the brachyblasts.

Fig. 2.7 is a representation of some of the different types of inflorescence systems found in *Otholobium*.

Proliferation, or alternating flowering and vegetative phases on the same axis (*Cytisus nigricans* L. and some *Wiborgia* species), does not occur in *Otholobium*.

In *Otholobium* the main florescence is the first to flower followed by sequential basipetal flowering of the paracladia. In *Psoralea* the terminal flowers flower first, followed by the lateral flowers (Fig. 2.8-1).

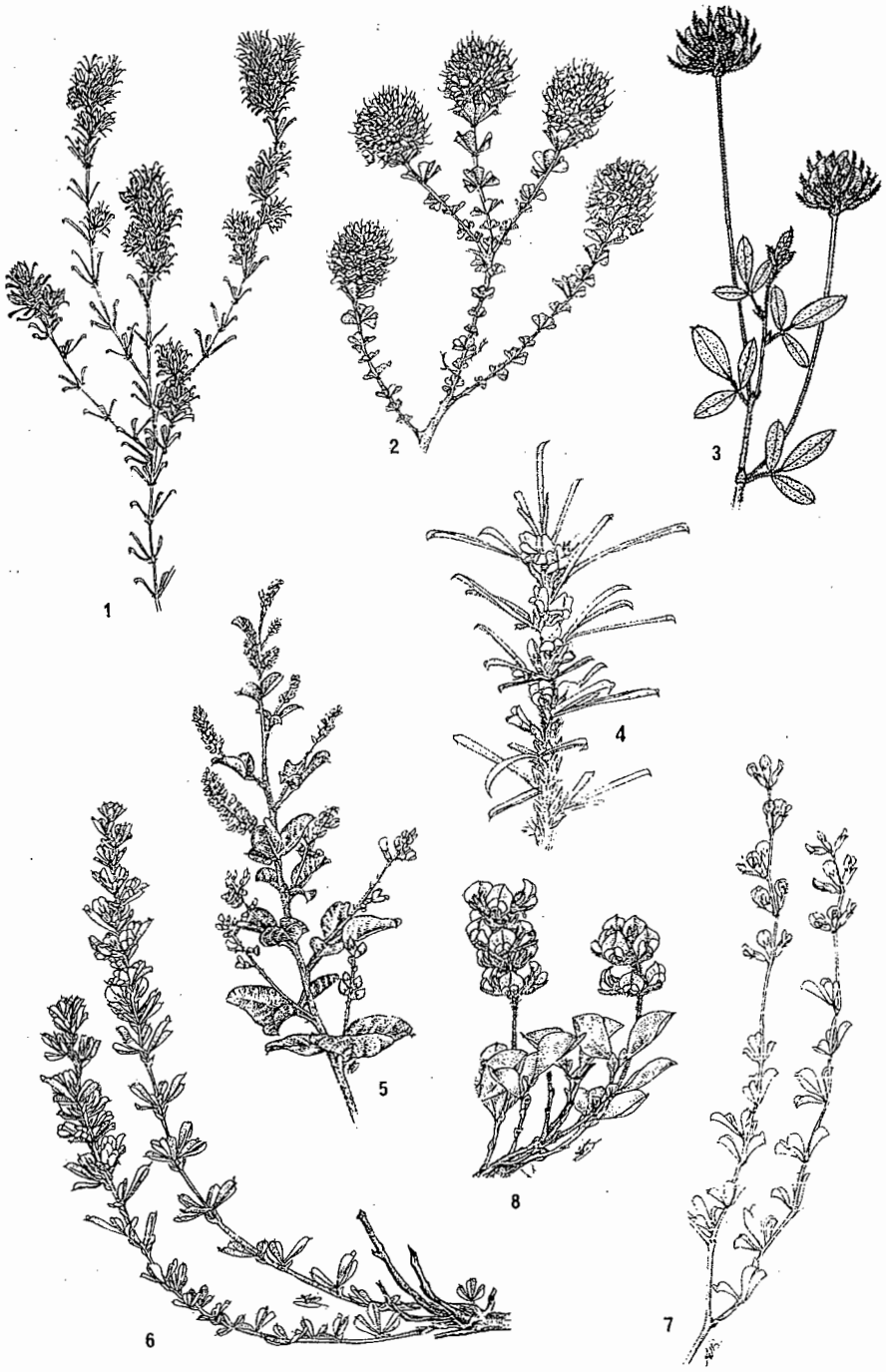


Fig. 2.7 Inflorescence types in *Otholobium*. 1, *O. carneum* (*Esterhuysen 6992*); 2, *O. acuminatum* (*Burchell 6004*); 3, *O. swartbergense* (*Stirton 10310*); 4, *O. bolusii* (*Stirton 6314b*); 5, *O. caffrum* (*Flannagan 2294*): 6, *O. piliferum* (*Sim 1213*); 7, *O. flexuosum* (*Stirton & Zantovska 11442*); 8, *O. rotundifolium* (*MacDonald 857*).

2.2.2.2.2. **Flower structure and development**

The flowers of Psoraleeae are typically zygomorphic, papilionoid flowers. There are a number of features of the flowers and their subtending bracts that are taxonomically useful, many of which have been used by other workers in the past to distinguish species.

Forbes (1930) employed seven floral characters from among the 25 characters she used to construct her key to southern African *Psoralea* s.l. Adamson and Salter (1950) used eight floral characters out of a total of 21 used in their general key. In this study 106 floral characters were surveyed out of a total set of 226 (reduced after 8 analyses to 96; of which only 25 floral characters were used in Key 2 based on inflorescences and flowers). 12 of the floral characters are employed here for the first time in key making: persistence and degree of flabellation of the triplet bract, calyx tube/calyx teeth ratio, width of carinal calyx relative to the other four teeth, fusion of vexillar teeth above the tube, length of calyx relative to flower length, presence or absence of appendages on the inner face of the standard petal, shape of standard petal, length of wing petals versus keel petals, degree of vestiture of ovary, and style and stigma respectively. Floral characters used by other authors but not used here include: 1, vestiture on inner face of the calyx teeth (universal in *Otholobium*); 2, degree of thickening of ribs on the calyx (similar and variable in *Otholobium* and *Psoralea*) and 3, density of glands on the calyx.

A unique feature among the Leguminosae is the presence of a **cupulum** subtending each flower in the genus *Psoralea* (Stirton 1981; Tucker, 1987a; Tucker, 1987b; Tucker & Stirton, 1989). The **cupulum** is a cup-like structure formed from the fusion of a number of bracts (Figs. 2.8 and 2.9.; see also Stirton, 1981b, Fig. 2, p. 339, reproduced in Chapter 1 of this thesis). A flower pedicel arises from within the cupulum and may or

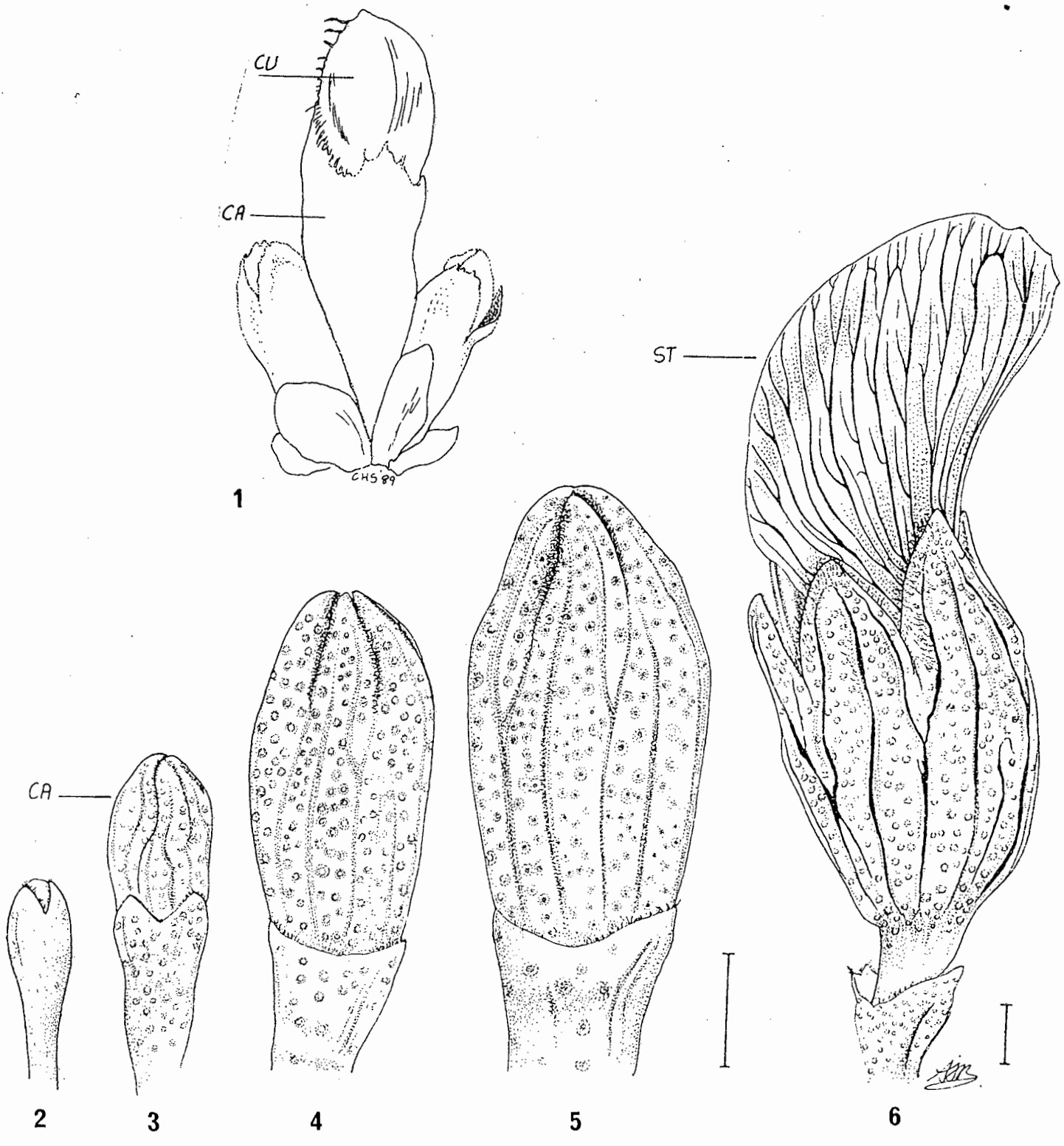


Fig. 2.8 Sequential flower development in *Psoralea pinnata* (*Stirton 9509*). 1, Flower buds of increasing height being formed from a growing cymose inflorescence axis; 2-6, Floral sequence showing emergence of the calyx from a cupulate structure: 1, 1,5 mm; 2, 2 mm; 3, 3 mm; 4, 4 mm; 5, 14,5 mm. Cu = cupulum; Ca = calyx; St = standard. Magnifications 1-5, bar = 1 mm; 6, bar = 10mm.

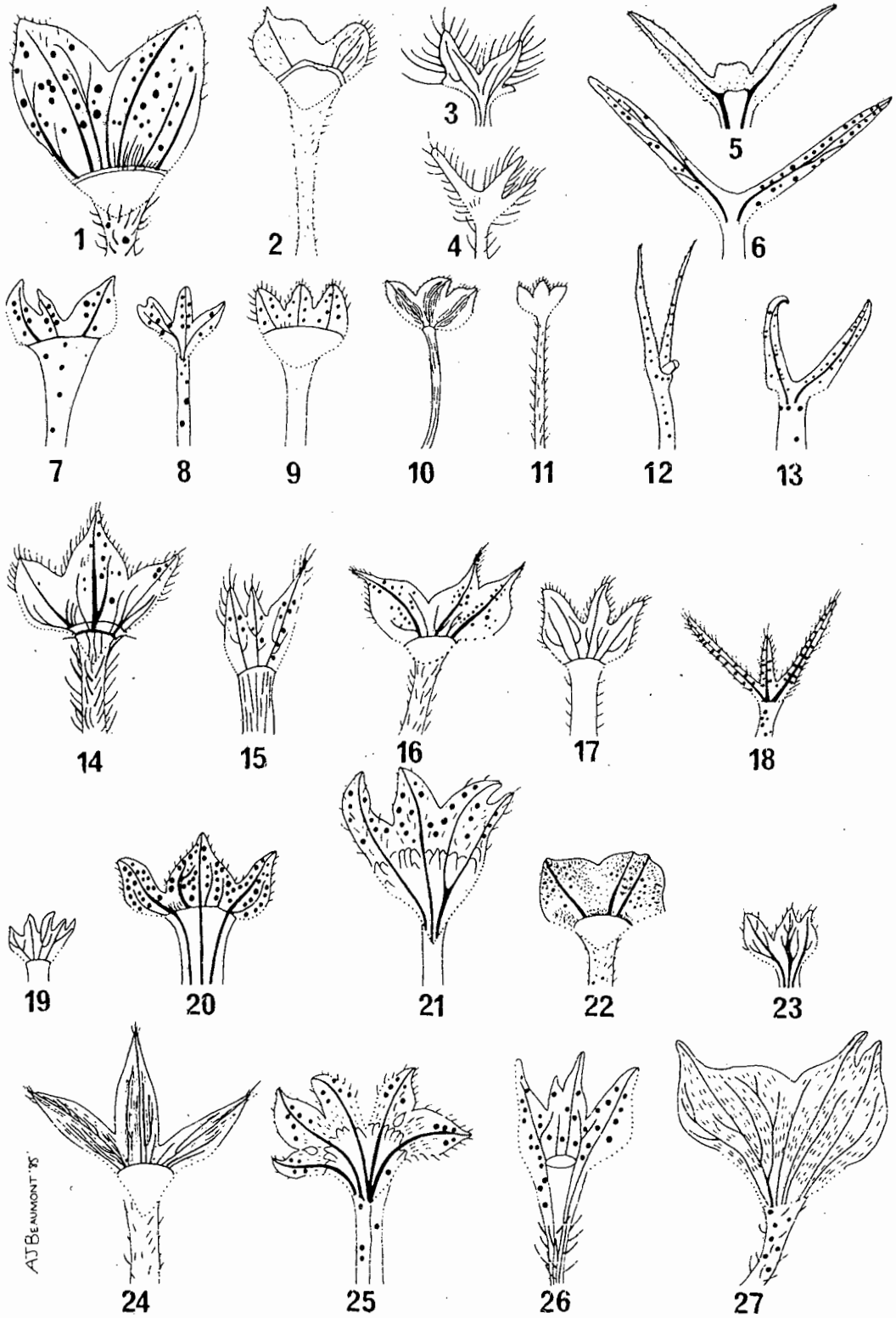


Fig. 2.9 Drawings of the cupulum, cleared and unrolled, from 27 species of African *Psoralea*. 1, *P. glabra* (*Stirton 9951*); 2, *P. glabra* (*Comins 976*); 3, *P. imbricata* (*Taylor 4396*); 4, *P. ensifolia* (*Prior* s.n.); 5, *P. restioides* (*Stirton 10767*); 6, *P. vlokii* (*Vlok 865*); 7, *P. glaucescens* (*Stirton 10158*); 8, *P. tenuifolia* (*Esterhuysen 26870*); 9, *P. angustifolia* (*Stirton 10287*); 10, *P. monophylla* (*Boucher 792*); 11, *P. laxa* (*Stirton. 9969*); 12, *P. trullata* (*Fourcade 2827*); 13, *P. oreophila* (*Esterhuysen 17*); 14, *P. pinnata* (*Stirton 9975*); 15, *P. glaucina* (*Salter 7883*); 16, *P. alata* (*P.Whellan 1756*); 17, *P. gueinzii* (*Duthie 1653*); 18, *P. fascicularis* (*Gillett 4431*); 19, *P. plauta* (*Pegler 414*); 20, *P. speciosa* (*Barker 59*); 21, *P. nubicola* (* *10212*); 22, *P. latifolia* (*Prior* s.n.); 23, *P. asarina* (* *8420*); 24, *P. odoratissima* (* *8258*); 25, *P. verrucosa* (* *10190*); 26, *P. repen* (*Phillips* s.n.); *P. aculeata* (*Pappe* s.n.).

may not be subtended by a range of "bracts" varying from small tufts of black hairs to 1 - 7 bracts of different sizes. Fig. 2.9 (from Tucker & Stirton, 1989) shows a representation of some of the diversity of this structure; note that the structures have been slit and opened with the inner face exposed. The cupulum furnishes a number of useful morphological and anatomical features (number, size and shapes of lobes; vasculature, glandulosity and vestiture).

2.2.2.2.3. **Discontinuity plate**

One of the anatomical features used in the past to support the unification of the tribes Psoraleeae and Amorpheae is the so-called **discontinuity plate**, a discontinuity of the xylem connections between the pistil, petals and androecium with the pedicel. The plate is a proliferation of xylem tissue at the base of the pistil or as Lersten and Wemple (1966) put it - the formation of "**a mass of tracheary elements flaring out horizontally from the lower end of the merged gynoecial bundles** (Brady, Wemple & Lersten, 1964; Lersten & Wemple, 1966; Wemple & Lersten, 1966). Lersten and Wemple (1966) referred to the discontinuity plate as "**a definitive floral characteristic of the Psoraleeae**".

Two other major studies were made subsequently. Lang (1972) surveyed 110 species of Amorpheae and found that the discontinuity plate was present and constant in all species and that it was fully mature before anthesis. This work was repeated and extended by Grimes (1987) who also looked at representatives of the tribes Sophoreae, Dalbergieae, Adesmieae, Aeschynomeneae, Carmichaelieae, Loteae, Mirbelieae, and Trifolieae. Unfortunately, Grimes (1987) justified his otherwise worthwhile paper on a serious misinterpretation of my paper (Stirton, 1981b) claiming that I had supported a close relationship between the two tribes based on the continuity plate, when in fact I had stated quite unambiguously that "**Their data** (papers cited above) **on the discontinuity plate has been invoked to reflect at least an early common ancestry between the**

two tribes. In my opinion there is insufficient data on which to base such a confident assessment."

Grimes (1986) has made a most useful contribution to our understanding of this anomalous structure in showing that it occurs in two more tribes than had been reported previously and that it comprised four types (Fig. 2.10). He has provided good evidence that my reservations, voiced in Stirton (1981b), were sound ones. Unfortunately he has failed to resolve the crucial question as to whether these types are homologues and hence the data's use for phylogenetic studies is still uncertain. His data does support other data presented in this thesis that the Desmodieae may be closely related to the Psoraleeae. The major difference between Psoraleeae and Amorpheae is that the plate in Amorpheae is always well-developed before anthesis, whereas in the other tribes the xylem development continues into fruiting. Grimes (1986) concludes correctly that convergence, parallelism and synapomorphy are three equally viable interpretations of his results, that the plate in Desmodieae and Psoraleeae is "much more similar" than between Amorpheae and Psoraleeae, and that finally current evidence is not much help until the problem of homoplasy has been resolved.

2.2.2.1.6. **Leaf variation**

The leaves of *Cullen*, *Psoralea* and *Otholobium* are easily distinguished. In *Otholobium* they are usually digitately or pinnately trifoliolate, usually with the laterals smaller than the terminal leaflet and in many species asymmetrical, rarely unifoliolate; mucronate, the mucro usually recurved but also arching or straight, stout or setiferous; laminate (never terete), flat to conduplicate, sessile to petiolate; with entire margins, the glands usually raised but also flush with the surface. In *Psoralea* the majority of the species have linear to linear-oblong, digitate or 3 -- 11 foliolate leaves, usually terete in

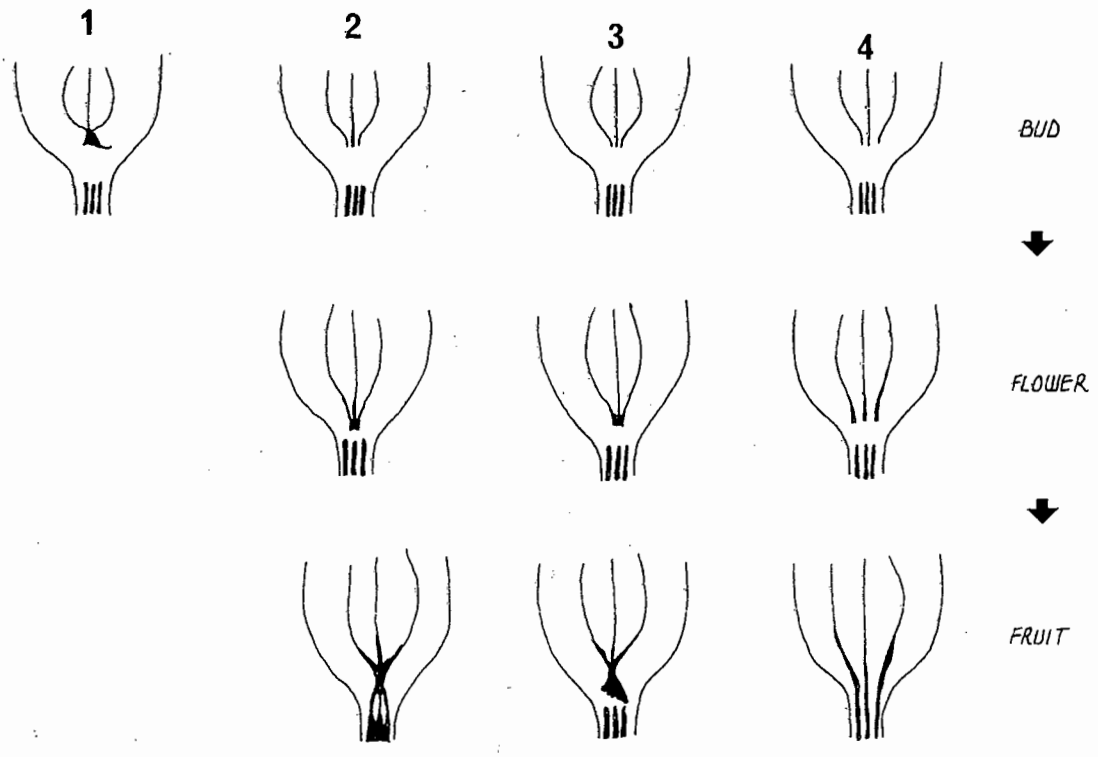


Fig. 2.10 Diagrammatic representation of the development of xylem from bud to fruit stage in the tribes Psoraleeae, Amorpheae, *Desmodium* (Desmodieae) and *Tephrosia* (Millettieae). Redrawn from Grimes (1987). Column 1, Amorpheae (all genera); 2, Psoraleeae (All New World genera; Old World genera *Psoralea* and *Otholobium*); 3, Psoraleeae (Old World genera *Cullen*, *Bituminaria* and *Otholobium*; Desmodieae (*Desmodium*); and 4, Millettieae (*Tephrosia*).

cross-section (exceptions being subgenus *Hallia*, rarely flattened, mostly with embedded glands; pseudo-mucronate in *P. aculeata*; absent or scale-like in the *P. aphylla* complex). In *Cullen* the leaves are mostly toothed with undulating margins. The African genera never have pedate or palmate leaves as in some Amorpheae and in some North American taxa such as in *Psoralea* (*Rhytidomene*) *lupinellus*, with its palmately compound leaflets, and *Psoralea* (*Pediomelum*) *esculentum*.

One of the most promising features for tribal and generic classification are the nature, ontogeny and morphology of the secretory cavities found in both Amorpheae and Psoraleeae.

The gland-dotted foliage in these tribes is a diagnostic feature and has been used as a grouping character in the past. Rydberg (1919) considered it an important character in his original delimitation of the Psoraleeae. In 1981 I wrote that "in general, the nature, ontogeny, and function of glands in the Papilionoideae are poorly known and very much in need of investigation" (Stirton, 1981b). Turner (1986) responded to this challenge and has since shown explicitly that these foliar "glands" are **secretory cavities** and that their ontogeny is quite different in each of the two tribes. So, far from being a uniting character, gland features separate the tribes unambiguously. This supports my earlier conclusion that glands would be decisive in separating the tribes (Stirton, 1981b).

To the naked eye the glands in Psoraleeae appear either as translucent dots when a leaf is held against a light source or they may be opaque raised pustules.

"Glands" are not particularly common in the Leguminosae. They are known to occur in the tribes Amorpheae, Psoraleeae, and Phaseoleae (especially subtribe Cajaninae), and in different genera of seven other tribes (Hutchinson, pp. 300-301, 1964). It is evident that these "glands" range from internal secretory cavities (eg.

Hedysarum) or hemispherical trichomes (eg. *Eriosema* and *Rhynchosia*). Glands are classified variously: by their structure and ontogeny; by the type of product they secrete and how it arose metabolically; and by the location of the secretion deposition (Lüttge, 1971; Napp-Zinn, 1973; Fahn, 1979). The major substances secreted by glands are usually referred to loosely as inorganic salts, polysaccharides, proteolytic enzymes, resins, sugars and waxes (Lüttge, 1971). See Dell and McComb (1978) for specific definitions of resins, essential oils, latexes, gums, waxes and nectars.

In the Psoraleeae and Amorpheae the glands are resin-containing secretory cavities (De Bary, 1877; Hildebrand, 1866; von Honel 1881; Vuillemin, 1891; Weyland, 1893; Solereder, 1908; Napp-Zinn, 1973; Turner, 1986). The ontogeny of these secretory cavities has been studied in detail by Turner (1986). He distinguishes an **epidermal type** in Psoraleeae and a **subepidermal type** in Amorpheae. Detailed developmental studies of eight representative species in these tribes indicated that these gland types were non-homologous.

In Psoraleeae the glands develop from an elongation and separation of epidermal cells with a concomitant development of a surrounding sheath-like layer from the hypodermis. Both trabeculate (bulge above the surface) and non-trabeculate (flush or sunken) types occur; both have a characteristic inner layer of parallel, elongated, epithelial cells, and are situated on both surfaces of the leaf. In the Amorpheae the protodermal initials divide periclinally to form two layers; an external layer which matures into epidermis and an interior layer which continues to divide to form a subepidermal group of cells which eventually form an epithelial layer once schizogeny develops. No trabeculae occur in the glands of this tribe and all glands are restricted to the abaxial side of the leaf.

2.2.2.1.6.1 **Distribution of "glands" in Psoraleeae**

The only detailed survey of glands in Psoraleeae and Amorpheae is that of Turner (1984, 1986). His results are summarised in Table 2.5. Unfortunately he only studied 7 species of *Otholobium*. I have therefore amended Table 2.5 to include new data for *Otholobium* extracted from Table 2.6. My results generally confirm his study except for an estimation of the number of trabeculae in each cavity. For *Otholobium decumbens* (= *O. virgatum* here) he obtained 3-6 trabeculae whereas I recorded 10-13. However, this is a highly variable species with distinct local forms, so would merit a closer study. I did not find any trabeculae in *O. sericeum*, whereas he recorded 7-10 and 10-20+ for two different collections. This species has a small secretory cavity which lacks trabeculae.

2.2.2.1.6.2 **Methods**

Leaf clearings were made from herbarium leaflets using modified versions of Klucking's (Klucking, 1986) and Lackey's (Lackey, 1978) methods. The leaves were cleared in 5% aqueous NaOH until they were clear. They were then washed 3 times in distilled water, once in acetic acid, then again in three changes of distilled water. The washed leaves were then placed in common household bleach until they became translucent. This was a critical step for if the leaves were left in the bleach too long they decomposed into mush. The leaves were next washed in distilled water and then placed in a super-saturated solution of chloral hydrate solution for 2-3 days. Material left in this solution for more than a week became extremely fragile and is not recommended as is suggested by some authors (eg. Klucking, 1986). However, I discovered that with care the leaves can at this stage be washed carefully onto a microscope slide and observed for detail under a compound microscope. The smell is not to be recommended though!

The following features were found to be easily observed in the chloral hydrate stage as long as the leaf was not too thick: stomata, large rhomboid crystals only, depth and shape of secretory cavities, uniseriate and glandular hairs, and tracheoid idioblasts. The trabeculae were very distinctive under phase contrast lighting. Focusing through the specimens was unimpeded. In a number of instances the secretory cavities were filled with a dark substance which interfered with viewing the trabeculae. For such species it was necessary to complete the clearing sequence by passing the leaves, after a wash in distilled water, through an ethanol-xylene dehydration series. Both chlorozol black E and safranin stains were used (Lackey, 1978; Turner, 1986). The time the material was left in each stain was critical; under and overstaining occurring more often than what was required. The safranin staining as expected enhanced observation of the venation and especially the tracheoid idioblasts. In these preparations the smaller mesophyll crystals were most easily observed.

2.2.2.1.6.3 **Leaf anatomy of** *Otholobium*

Four features showed enough variation to be recorded. These are presented in Table 2.6.

a. In the majority of species the secretory cavities occur in both epidermises. There are a few exceptions which only have cavities in the abaxial epidermis: *O. pungens*, *O. saxosum*, *O. sericeum*, *O. spissum*, *O. swartbergense* and *O. thomii*. *O. sericeum* and *O. swartbergense* are a vicariant species pair.

b. Different species varied in the number of trabeculae present in each secretory cavity and whether these converged into a small plate at the apex of the cavity. 56% of the species had less than 30 trabeculae per cavity. The number of trabeculae per cavity ranged from 7 -- 10 in *O. venustum* to more than 70 in *O. heterosepalum*. The following frequencies were noted: 0 -- 10 in 15 spp.; 20 -- 40

Table 2.5 Summary of anatomical features of genera of the Psoraleeae. Data from Turner (1986) and Stirton, this study (Marked with *)

Genus	Cavity type No. of trabeculae	Number of trabeculae per cavity	Location of cavity (adaxial/abaxial)	Dominant stomatal type	Pattern of stomatal distribution on both surfaces	Glandular trichomes
1. PSORALEEAE						
Bituminaria	Epidermal	(7) 10-20+	both	Paracytic	Amphistomatic	+
Cullen	Epidermal	(7) 10-20+	both, mostly abaxial	Paracytic	Amphistomatic	+
Hoita	Epidermal	(7) 10-20+	both	Mostly paracytic, one anomocytic	Amphistomatic	-
Orbexilum	Epidermal	3-6 or (7) 10-20+	Both, or only adaxial	Paracytic	Amphistomatic	+
* *Otholobium*	Epidermal	0-2, 3-6, 7-10, 10-20, *30-45, *50-70	Both, or mostly abaxial, or mostly adaxial	Paracytic	Amphistomatic (1 sp. hypostomatic)	+
Pediomelum	Epidermal	0-2 or 3-6 2 spp. with (7) 10-20	Both, or mostly adaxial or only adaxial	Paracytic	Amphistomatic	+
Psoralea	Epidermal	0-2	Both	Paracytic	Amphistomatic	-

My own studies confirm Turner's observations of leaflet anatomy in *Otholobium* and *Psoralea*, except that there are many species of *Otholobium* that have 40 or more trabeculae per secretory cavity.

Summary of anatomical features of genera of the Amorpheae. Data from Turner (1986).

Genus	Cavity type No. of trabeculae	Number of trabeculae per cavity	Location of cavity (adaxial/abaxial)	Dominant stomatal type	Pattern of stomaty	Glandular trichomes
2. Amorpheae						
Amorpha	Subepidermal	0	Abaxial	Anomocytic,	Hypostomatic	-
Apoplanesia	Subepidermal	0	Abaxial	Anomocytic	Hypoamphistomatic	-
Dalea	Subepidermal	0	Abaxial	Anomocytic	Amphistomatic	-
Errazurizia	Subepidermal	0	Abaxial	Anomocytic	Amphistomatic	-
Eysenhardtia	Subepidermal	0	Abaxial	Anomocytic, or cyclocytic	Amphistomatic, Hypostomatic or hypoamphistomatic	-
Marina	Subepidermal	0	Abaxial	Anomocytic	Amphistomatic, some hypostomatic	-
Paryella	Subepidermal	0	Abaxial	Anomocytic	Amphistomatic	-
Psorothamnus	Subepidermal	0	Abaxial	Anomocytic	Amphistomatic	-

Table 2.6 Summary of anatomical features of genus *Otholobium*. Data from Stirton, this study.

Species of *Otholobium*	Voucher specimen	Location of cavity (adaxial/abaxial)	Number of trabeculae per cavity	Proportion of trabecular convergence relative to diameter of cavity (of 1)	Convergence of 2-3 trabeculae into a single strand	Comments
accrescens	Rodin 1128	Both	16-20	.33	+	Tannin sacs present
acuminatum	Thom 489	Both	50-60	.25	+	
argenteum	Drege s.n.	Both	10-15	.25	+	Covered in dense uni-seriate hairs
bolusii	Gillett 4151	Both	10-15	.25	+	
bowieanum	Bowie s.n.	Both	15-20	.18	+	
bracteolatum	Van Breda 1667	Both	50-67	.16	+	
caffrum	Strey 8688	Both	16-20	.33	+	
candicans	Pearson 4811	Both	10-13	.30	+	Cavities few, stomata dense on both surfaces
carneum	Esterhuysen 6992	Both	20-25	.20	+	
foliosum	Richards 9638	Both	11-15	.17	+	Cavities, large and scattered
gazense	Norlindh 4240	Both	40-50	.25	+	Cavities large
heterosepalum	Thode 806	Both	70+	.50	+	Cavities variable in size, stomata numerous
hirtum	Worsdell s.n.	Both	50-70	.30	-	Cavities same size
incanum	Acocks 19782	Both	15-20	.16	+	Numerous cavities

Species of *Otholobium*	Voucher specimen	Location of cavity (adaxial/abaxial)	Number of trabeculae per cavity	Proportion of trabecular convergence relative to diameter of cavity (of 1)	Convergence of 2-3 trabeculae into a single strand	Comments
macradenium	Prior s.n.	Both	10-15	.16	+	Numerous small stomata
mundianum	Tyson 1664	Both	40-60	.25	+	
nitens	Esterhuysen 35743	Both	50-60	.20	+	
obliquum	Garside 245	Both	65-70	.20	+	
parvifolium	Garside 1163a	Both	15-20	.13	+	
pictum	Taylor 1285	Both	35-40	.25	+	
pilliferum	Bulcock s.n.	Both	20-25	.20	+	Numerous crystals along all veins
polyphyllum	Ecklon & Zeyher s.n.	Both	19-20	.20	+	
polystictum	Burke s.n.	Both	16-18	.20	+	
prodens	MacOwan 963	Both	60+	.40	+	Cavities numerous
pungens	Taylor 7300	Abaxial	10-15	.25	+	Cavities few, scattered
pustulatum	Acocks 19581	Both	30-50	.16	+	Cavities numerous
racemosum	Bond 855	Both	30-35	.16	+	
rotundifolium	MacDonald 857	Both	30-60	N/A	N/A	
rubicundum	Wurts 1606	Both	50-71	.25	+	

Table 2.6 Summary of anatomical features of genus *Otholobium*. Data from Stirton, this study.

Species of *Otholobium*	Voucher specimen	Location of cavity (adaxial/abaxial)	Number of trabeculae per cavity	Proportion of trabecular convergence relative to diameter of cavity (of 1)	Convergence of 2-3 trabeculae into a single strand	Comments
saxosum	Stirton 11264	Abaxial	25-35	.33	+	
sericeum	Hutchinson 1243	Abaxial	0	N/A	N/A	Numerous stomata below, few small tracheoid idioblasts
spicatum	Ecklon s.n.	Both	50-80	.33	+	Numerous cavities
spissum	Esterhuysen 35047	Abaxial	25-30	.25	+	cavities very few
stachyerum	Stirton 9630	Both	50-60	.35	-	Cavities variable in size
striatum	Zeyher s.n.	Both	30-50	.25	+	Numerous glandular hairs and stomata
swartbergense	Bolus 11746	Abaxial	0	N/A	N/A	Similar to *O. thomii*
thomii	Bowie s.n.	Abaxial	0	N/A	N/A	
trianthum	Esterhuysen 4029	Both	40-45	.25	+	Stomata among largest in genus
venustum	Compton 24196	Both	7-10	.20	+	Cavities variable in size
virgatum	Prior s.n.	Both	10-13	.30	+	Cavities variable in size
wilmsii	Wilms 295	Both	20-25	.25	+	Has many cavities, variable in size

in 11 spp. and 40 -- 70+ in 16 spp. There does not seem to be any distinct patterns to these frequencies except that all of the lowland Cape species have less than 20 trabeculae per cavity. However, this does not hold for the eastern highland species. Similarly, the ratio of the convergence plate to the diameter=meter of the cavity shows great variability, ranging from 0,13 in *O. parviflorum* to 0,50 in *O. heterosepalum*. Apart from *O. hirtum*, *O. rotundifolium* and *O. stachyerum* (Fig. 2.1[1,2]), in which the trabeculae do not meet to form a plate, but in which gland cells extend from the cavity walls towards the centre of the cavity, there are three species which also lack trabeculae. The latter species have a different type of cavity (Fig. 2.1[3]); a small cavity in which gland cells are confined to the periphery of the cavity next to a protective sheath (*O. thomii*, *O. swartbergense* and *O. sericeum*).

Grimes (Lewis, pers. com., noted from returned determinavits, 1987) has suggested that the South American group of Orbexilums he was earlier referring to as "*Rupertia*" should be Otholobiums. There is some superficial similarity with the small *O. sericeum* group in leaf appearance and pubescence but the cavity types are quite different. In the South American species the cavities are deep, large, with many trabeculae and a large trabecular convergence. I have seen fresh material of three "*Rupertia*" species and conclude after careful analysis that their inflorescence and flower structure is very different from African Otholobiums. The scent and colours are quite different from the African species and the wing petals are not borne in the characteristic manner of *Otholobium*.

c. Glandular hairs, similar to those found in the Phaseoleae (Lackey, 1978), are common in the genus and were found on the leaves of all species though in different concentrations ranging from few and scattered in *O. spissum* to many and concentrated in *O. accrescens*, *O. gazense*, *O. incanum*, *O. polystictum*, *O. pus-*

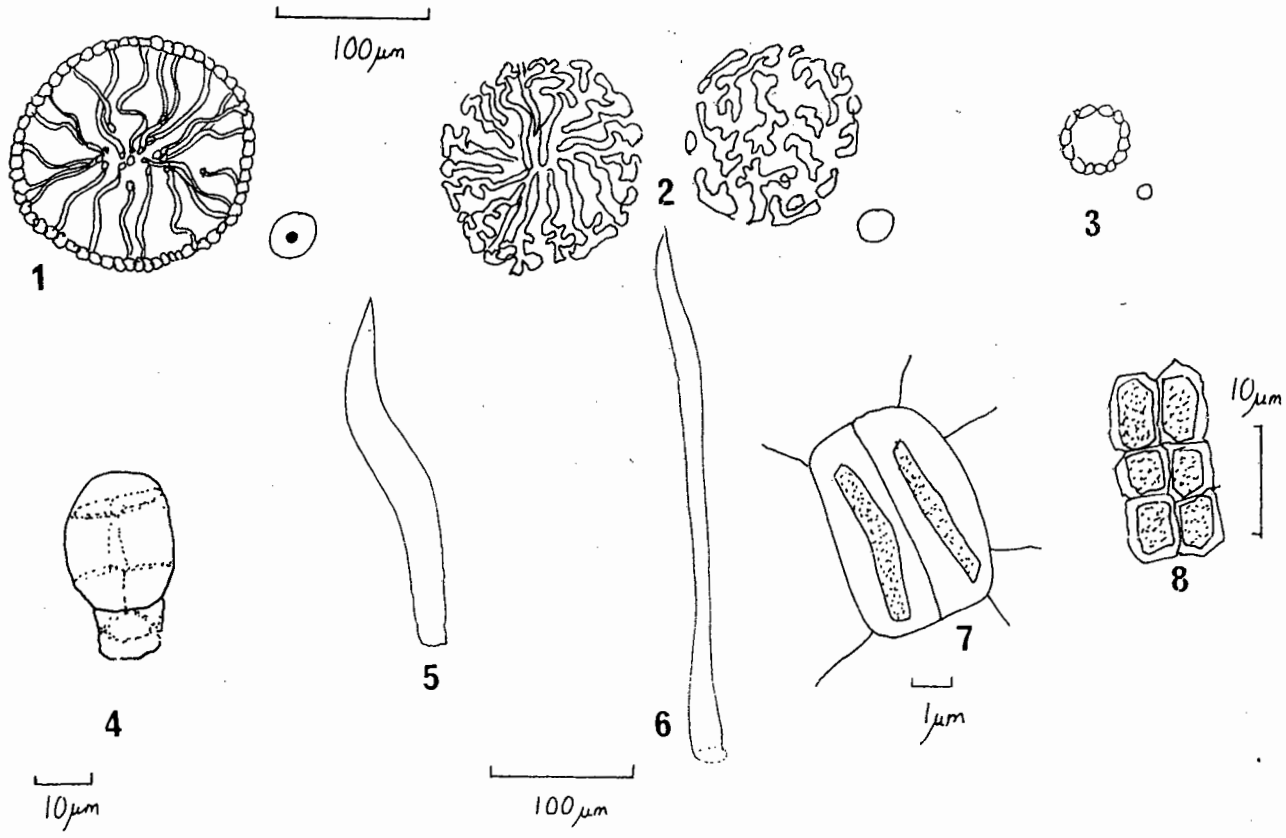


Fig. 2.11. Details from leaf anatomy of *Otholobium*. **1-3.** Types of secretory cavities in *Otholobium*: 1, *O. mundianum*; 2, *O. rotundifolium*; 3, *O. thomii*. **4-6.** Vestiture: 4, Stalked gland; 2, Short uniseriate hair; 6, Long elongated uniseriate hair. **7-8.** Crystal types: 7, Rod-shaped crystals of the palisade and spongy mesophyll; 8, Large prismatic crystals associated with bundle sheaths.

tulatum and *O. striatum*. Each gland is comprised of a multicellular head supported by a uniseriate stalk.

d. Calcium oxalate crystals were found in all species of *Otholobium* (Fig. 2.11,7-8). Two types were found: 1, Large prismatic crystals associated with bundle sheaths (never on fifth order veins) and 2, rod-shaped crystals associated with the palisade and spongy mesophyll. *O. piliferum* contained the most crystals in the genus. These findings are similar to those by Turner (1986), Solereder (1908), Weyland (1893) and Zindler-Frank (1988).

e. Tannin sacs were abundant in a number of species: *O. accrescens*, *O. pictum* and *O. rubicundum*.

The following conclusions concerning the African Psoraleeae may be drawn from these combined studies (new data from this survey):

1. Variations of cavity structure are important in segregating genera of Psoraleeae. All African species have epidermal secretory cavities. *Psoralea* has 0 -- 3 trabeculae and *Otholobium* 6 -- **70+** trabeculae per cavity. The cavities occur on both sides of the leaf except in three species of *Otholobium* where they occur on the abaxial side (These species also have rhomboid crystals in the epidermis).

2. The dominant type of crystal idioblast contains a single rhomboid crystal (Fig. 2.11), **rarely two**, and is found most commonly in the bundle sheaths. They are usually absent from the epidermis and mesophyll. **There is another prevalent type of crystal which is of diagnostic value. These crystals are rod-shaped and are distributed variously in the epidermal and mesophyll regions but are never associated with bundle sheaths.**

3. Tannins are found predominantly in or around the bundle sheath and in isolated mesophyll cells.

4. All Psoraleas possess simple trichomes as well as glandular trichomes (Fig. 2.11), **the latter often scarce and scattered along the median groove of the adaxial surface of the leaf in *Psoralea*. Glandular trichomes occur in all Otholobiums and are commonest on species with dense vestiture.**

5. The stomata in *Psoralea* and *Otholobium* are paracytic and amphistomatic for most species except for *O. sericeum* and the *P. aphylla* complex (a group of essentially 9 leafless species).

2.2.2.1.6.2 **Tribal characters from leaf anatomy in Psoraleeae**

The following conclusions can be drawn from Turner's (1986) study of the tribes Psoraleeae and Amorpheae:

1. The Psoraleeae are characterised by small, club-shaped glands comprised of 4-8 secretory cells, arranged in two tiers and raised on a 2-celled stalk (Fig. 2.11). Similar glands do not occur in the tribe Amorpheae.

2. Based on the frequency distribution of different stomatal types the subsidiary cells of stomata in Psoraleeae are nearly always paracytic but may also comprise 3-5 subsidiary cells as well. In Amorpheae the stomata are predominantly anomocytic, but occasionally cyclocytic and paracytic. He concludes that the basic pattern in the two tribes is different. Ontogenetic studies are needed to explain the discrepancies.

3. Of lesser importance is the occurrence in most species of Psoraleeae of secretory cavities on both surfaces of leaves compared to their restriction to the abaxial surface in Amorpheae.

2.3 **Flowers**

Flower structure in *Otholobium* is very variable and, except for a few closely related species, is diagnostic for species (Fig. 2.12). There are four basic patterns of flowers: 1, *O. striatum* type (Fig. 2.12,22) - stubby, yellow with recurved calyx lobes; 2, *O. acuminatum* type (Fig. 2.12,27) - slender, brightly purple, mauve or blue, clustered on dense inflorescences with standards distinctly raised at anthesis; 3, *O. nitens* type (Fig. 2.12,42) - robust, pale-coloured, with corolla almost obscured by the calyx, hidden among subtending leaves; and 4, *O. pustulatum* type (Fig. 2.12,37) - narrow, with scarcely raised standards, pale coloured, usually on lax racemes.

2.3.1 **Corolla**

Corolla colour varies from white through cream to yellow, from pale to dark pink and from pale mauve through blue to purple.

2.3.1.1 **Standard petal (Vexillum)**

The standard varies in colour, size, shape and structure (Fig. 2.13). Three trends are discernible from Fig. 2.13: 1, a reduction in the length of the claw (almost sessile in *O. obliquum*); 2, an increase in the size of the auricles (very distinctive and elongated in *O. carneum*); and 3, increasing indentation of the apex of the standard.

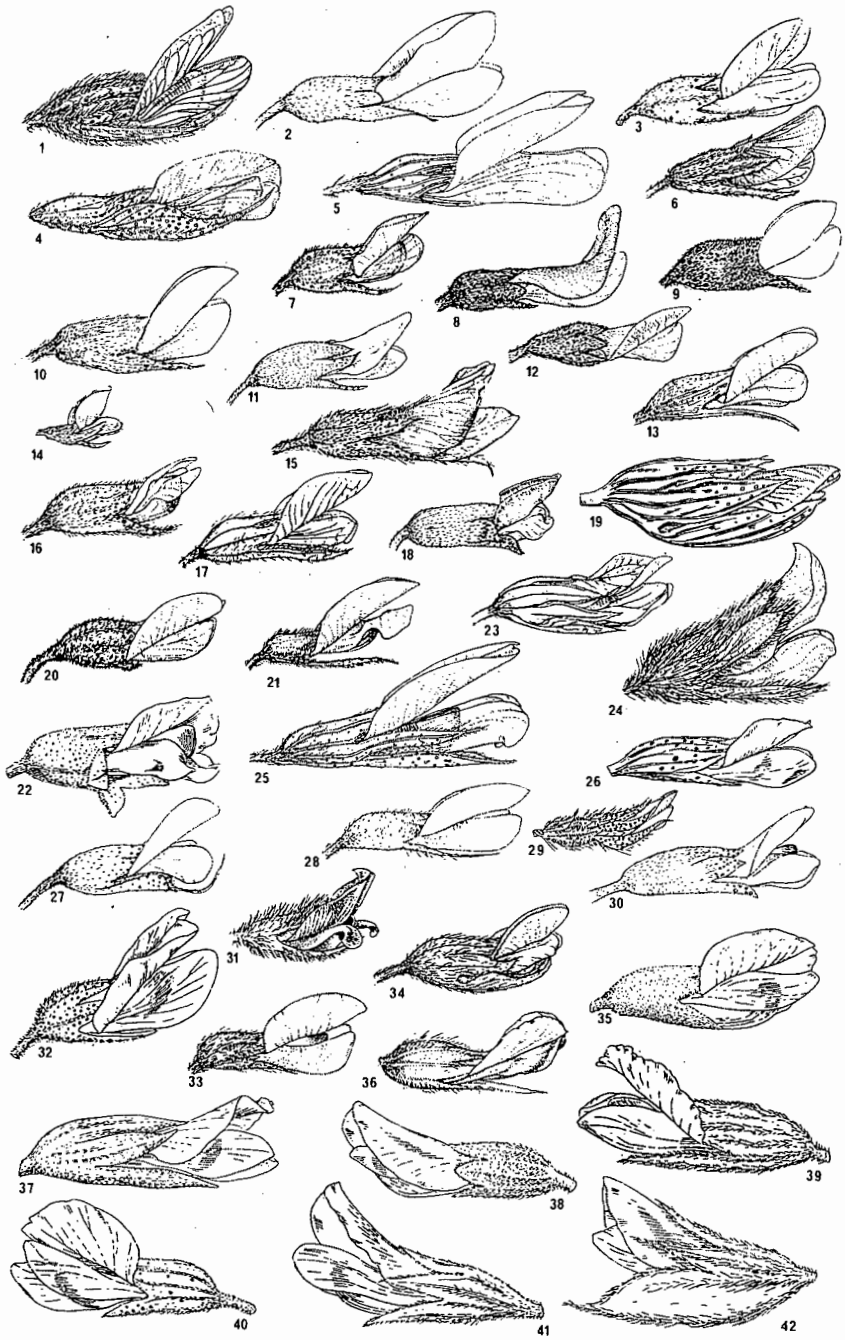


Fig. 2.12. Range of flower structure in *Otholobium*. 1, *O. bracteolatum* (*Van Breda 11667*); 2, *O. gazense* (*Stirton 10555*); 3, *O. foliosum* (*Milne-Redhead & Taylor 11007*); 4, *O. fruticans* (*Stirton 9963*); 5, *O. bowieanum* (*Stirton 11549*); 6, *O. polyphyllum* (*Scharf 1392*); 7, *O. polystictum* (*Jacobsz 494*); 8, *O. nigricans* (*Stirton 8923*); 9, *O. caffrum* (*Flanagan 2294*); *10, O. wilmsii* (*Compton 28693*); 11, *O. argenteum* (Drege s.n.); 12, *O. macradenium* (*Prior* s.n.); 13, *O. venustum* (*Nortier Experimental Station* s.n.); 14, *O. candicans*(*Stirton 11283*); 15, *O. obliquum* (*Garside 245*); 16, *O. spicatum* (*Parker 3862*); 17, *O. saxosum* (*Bolus 11264*); 18, *O. striatum* (Drege *s.n.*); 19, *O. heterosepalum* (*Fourcade 4225*); 20, *O. lucens* (*Marloth 12131*); 21, *O. mundianum* (*Stokoe 1052*); 22, *O. arborescens* (*Stirton 10153*); 23, *O. carneum* (*Esterhuysen 6992*); 24, *O. rotundifolium* (*McDonald 857*); 25, *O. piliferum* (*Sim 1213*); 26, *O. hamatum* (*Taylor 5526*); 27, *O. acuminatum* (*Burchell 6004*); 28, *O. bolusii* (*Stirton 6134b*); 29, *O. uncinatum* (*Stirton 8444*); 30, *O. flexuosum* (*Stirton & Zantovska 11422*); 31, *O. lanceolatum* (*Stirton 11381*); 32, *O. racemosum* (*Fourcade 6266*); 33, *O. virgatum* (*Stirton 9945*); 34, *O. stachyerum* (*Stirton 9620*); 35, *O. incanum* (*Acocks 17982*); 36, *O. parviflorum* (*Stirton 9938*); 37, *O. pustulatum* (*Acocks 19581*); 38, *O. fumeum* (*Marriott* s.n.); 39, *O. sabulosum* (*Esterhuysen 33240a*); 40, *O. trianthum* (*Salter 5679*); 41, *O. prodiens* (*Phillips 1109*); 42, *O. nitens* (*Esterhuysen 30375*).

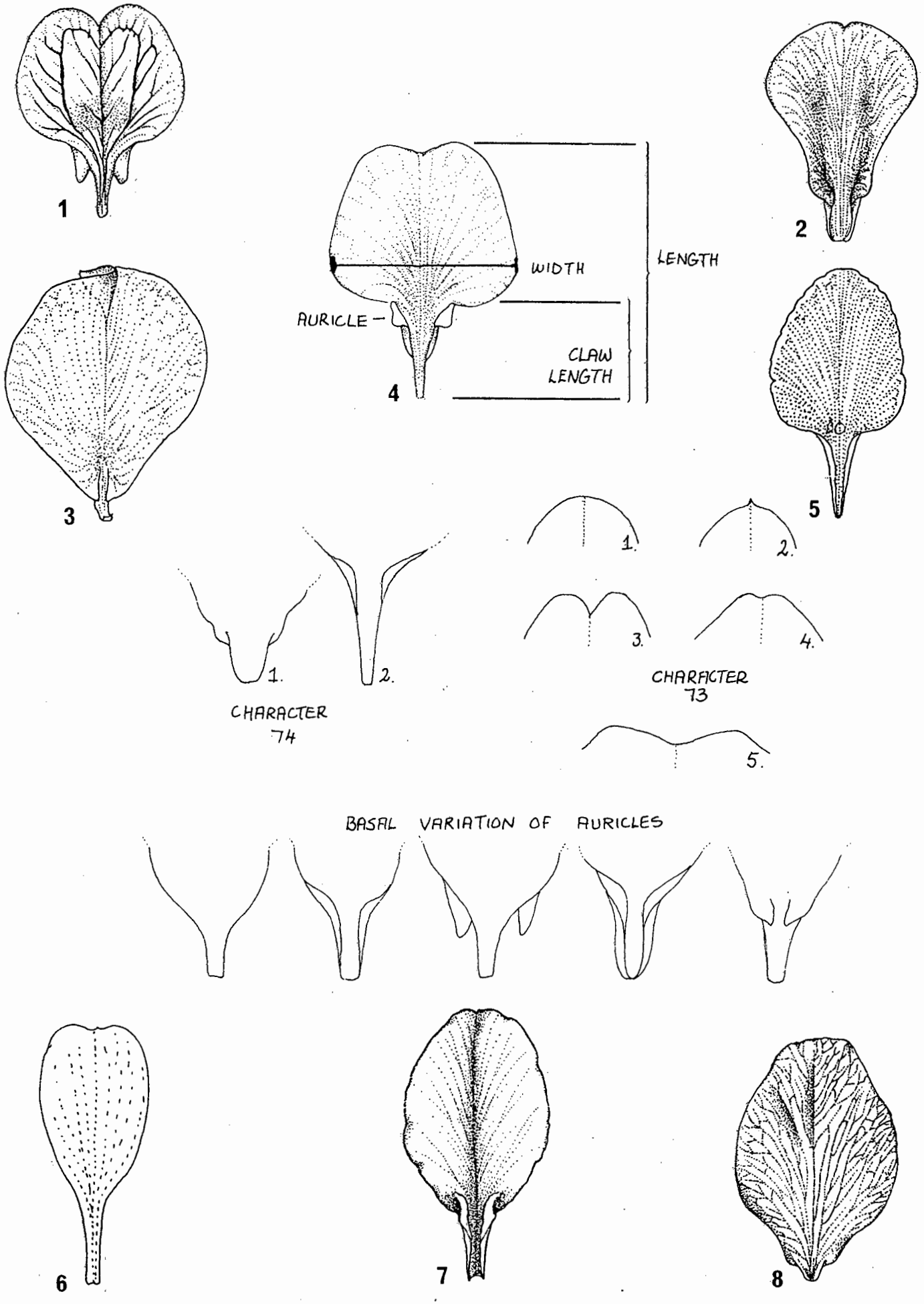


Fig. 2.13 Basic standard types in *Otholobium*. 1, *O. carneum*; 2, *O. striatum*; 3, *O. rotundifolium*; 4, *O. bolusii*; 5, *O. rubicundum*; 6, *O. uncinatum*; 7, *O. parviflorum*; 8, *O. obliquum*. DELTA Characters 73 and 74 are also shown. See Table 2.2 for character states. The drawing of *O. bolusii* indicates which measurements have been used in the species descriptions.

Auricles vary in size, and range from prominent inverted flaps (Fig. 2.13,1) to being absent (Fig. 2.13,6). The claw is either narrow and almost tubular or broad and flattened.

The back of the standard is glabrous. Secretory cavities are absent from all petals in *Otholobium* but do occur in two species of *Psoralea* (See Fig. 1.2). Nectar guides occur in most species and are usually a darker coloured patch just above the claw area. In some species (eg. *O. carneum*) the venation of the standard is distinctly coloured reddish purple or pink.

A distinguishing feature of the standard (Fig 2.13) is that it never reflexes vertically after flower opening as do flowers in *Psoralea*. This feature is shown clearly in the frontispiece depicting *O. bracteolatum*. This is due to the lack of callosities on the inner face of the standard petal; callosities are an autapomorphy of *Psoralea* (Psoraleeae).

2.3.1.2 **Wing petals (Alae)**

Wing petals show less variation than the standard petal (Fig. 2.14). The outlines indicated in Fig. 2.14 are unlike their shape in the fresh state. These have been flattened to indicate their shape. In *Otholobium* the wing petals are held characteristically with their distal edges incurved and overlapping. This can be seen clearly in the different aquarelles included in this thesis.

Wing petals appear to fall in to six shape groups. The blade is generally narrow, longer than the keel petals with the claw slender and elongated and always shorter than the blade. The commonest shape is oblong, the blade usually with a constricted proximal end. A few species, for example, *O. accrescens*, *O. nitens*, *O. rotundifolium*, *O. racemosum* and *O. caffrum*, have a broader upcurving blade with a convex base.

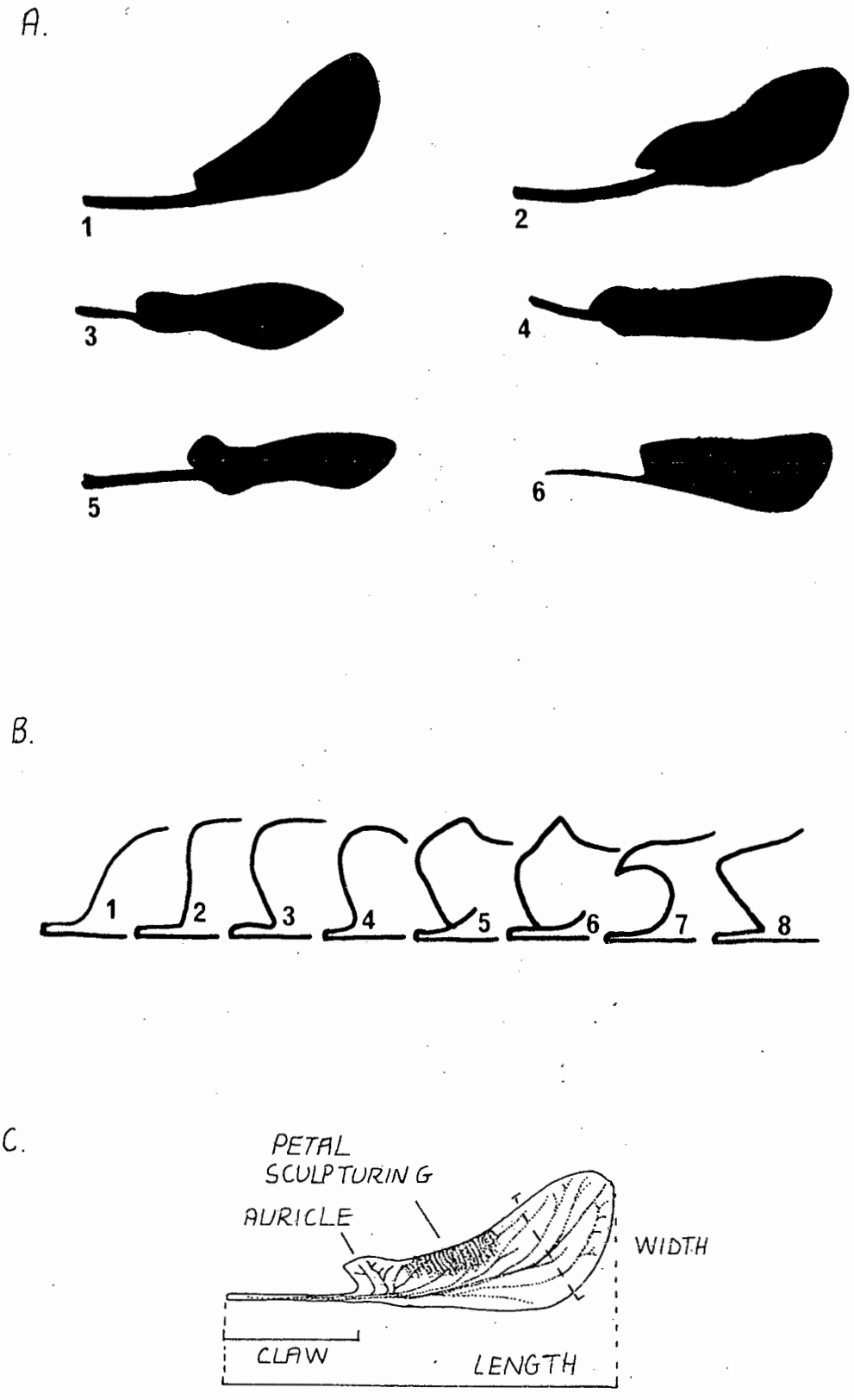


Fig. 2.14. Wing petals in *Otholobium*. A, Shapes of wing petals: 1, *O. caffrum*; 2, *O. arborescens*; 3, *O. rubicundum*; 4, *O. saxosum*; 5, *O. uncinatum*; 6, *O. bolusii*. B, Shapes of auricles: 1, *O. saxosum*; 2, *O. fumeum*; 3, *O. pungens*; 4, *O. bowieanum*; 5, *O. polyphyllum*; 6, *O. carneum*; 7, *O. parviflorum*; 8, *O. hamatum*. C, Wing petal of *O. accrescens* showing sculpturing and points of measurement.

The wing petals may or may not be fused to the keel petals in the auricle area. The auricle is very variable and is correlated with the size of the auricle of the keel petals and the degree of reflexion of the standard (Fig. 2.14). It is either prominently perpendicular as in *O. fumeum* and *O. foliosum*, convex as in *O. fruticans* and *O. prodiens* or recurved as in *O. arborescens* and *O. incanum*. It is very well-developed in *O. parviflorum*.

Each species has a distinctive petal sculpturing pattern on the proximal outer surface which facilitates a gripping surface for visiting insects, usually bees. Terminology used to describe this phenomenon is given in Stirton (1981d; Fig. 2.15; Appendix 17) and is used in the descriptions of sculpturing for each species in the taxonomic part. Typically in *Otholobium* the sculpturing is either upper basal, or upper basal and upper central, and is comprised of between 6 -- 60 inter- and/or transcostal lamellae (Table 2.7). It is clear form these data that the shape and position of these lamellations are not arbitrary, but are an important aspect of the pollination complex as a whole. This concept is discussed in detail in Stirton (1981d) which also provided the first general overview of petal sculpturing in the Papilionoid Leguminosae. Fig. 2.16 shows the pattern of localization of the different species. A comparison of this data with *Aspalathus*, another predominantly Cape genus, shows that pattern 6, which is commonest in *Otholobium*, does not occur in *Aspalathus*; in the latter genus patterns 2 and 3 dominate.

In 96% of the species there is only a single row of lamellations; the rest never have more than 3 rows and these are usually somewhat ill-defined. Lamellations are in most species slender or weakly developed, but in some they are robust and thickened, eg. *O. heterosepalum*, *O lanceolatum*, *O. polyphyllum* and *O. sericeum*. In *Aspalathus* there are commonly 3 -- 4 rows of lunae, compared to the usually single row of lamellations in *Otholobium* (Fig. 2.16; lunae are absent from the Psoraleeae).

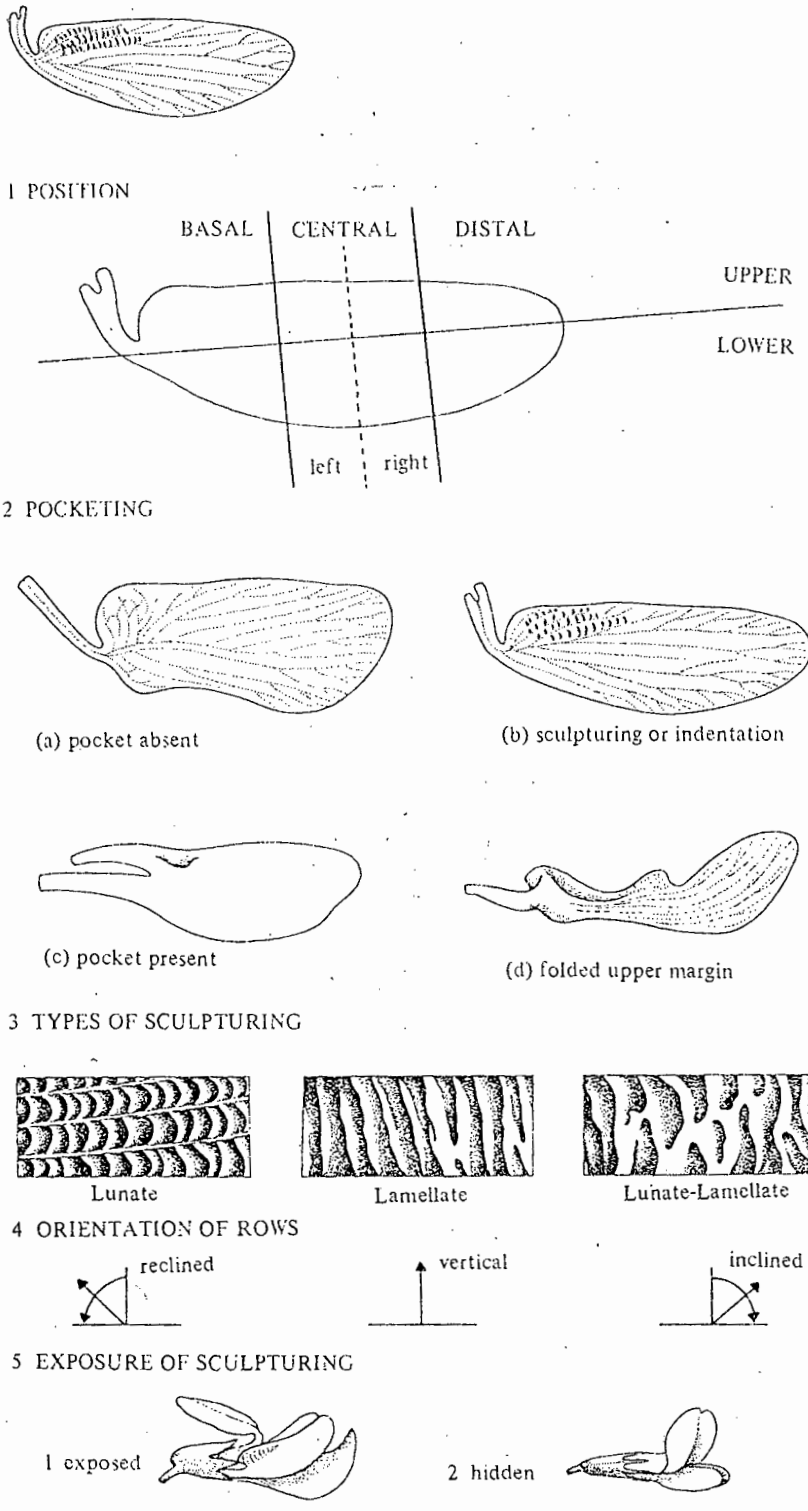


Fig. 2.15 Terminology used to describe wing petal sculpturing (After Stirton, 1981c).

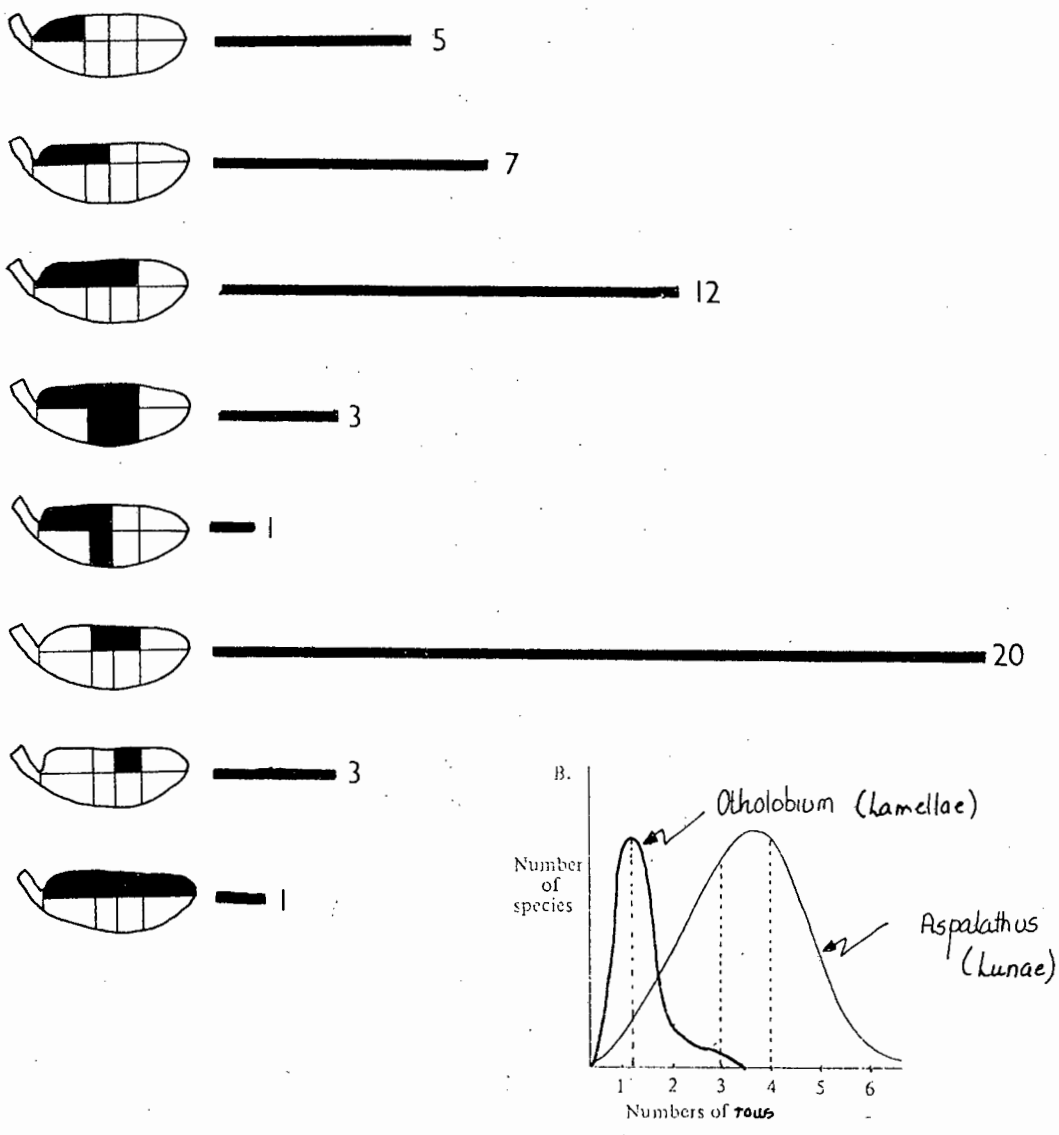


Fig. 2.16 Localization of sculpturing on wing petals of 52 species of *Otholobium* in Africa. **A**. Sculpturing occurs in eight zones; groups 3 and 6 represent the majority of species. **B**. This inset graph compares the number of rows of lunae versus lamellae in *Aspaiathus* and *Othoiobium*. The number of rows of lunae and the number of lunae in a row is almost identical in *Aspalathus*.

The combination of sculpturing pattern and of wing petal shape is diagnostic of species in *Otholobium*. In some cases it has been definitive in separating species such as *O. sericeum* and *O. swartbergense* which were previously considered the same species.

The only other recording of sculpturing patterns in Psoraleeae s.l. is by Tewari & Nair (1979) who described patterning in *Psoralea* (*Cullen*) *corylifolia* L. The tribe Amorpheae, which was recorded by Stirton (1981d) as not having petal sculpturing patterns does in fact have a number of species with distinctive semi-circular rows of lunate sculpturing; a pattern quite unlike anything found in the tribe Psoraleeae. Petal sculpturing therefore constitutes another character which separates the two tribes.

2.3.1.3 **Keel petals**

There are eight basic keel shapes in *Otholobium* (Fig. 2.17a). Apart from *O. candicans* the claw of the petal is either longer than or equal to the length of the blade; almost 1,5 times longer in *O. acuminatum*. There is usually an auricle. In *O. pungens* it is absent, but in *O. fruticans* and *O. bracteolatum* it is well-developed. The apex of the blade is variable but easily described using Hickey's (1979) classification of serration types (See Fig. 2.17b).

Keel petals are fused along their lower margin from just beyond the distal part of the claw to the apex of the blade. Every species has a distinctive purple patch on the inner face of each keel blade. This discolouration (See Chapter 6) could be an autapomorphy for the tribe Psoraleeae.

Keel petals are always shorter than wing petals. Only *O. sericeum* has petal sculpturing on the outer face of the keel blade. Venation is generally fine and hardly discernible but in *O. polyphyllum* it is distinctively thickened.

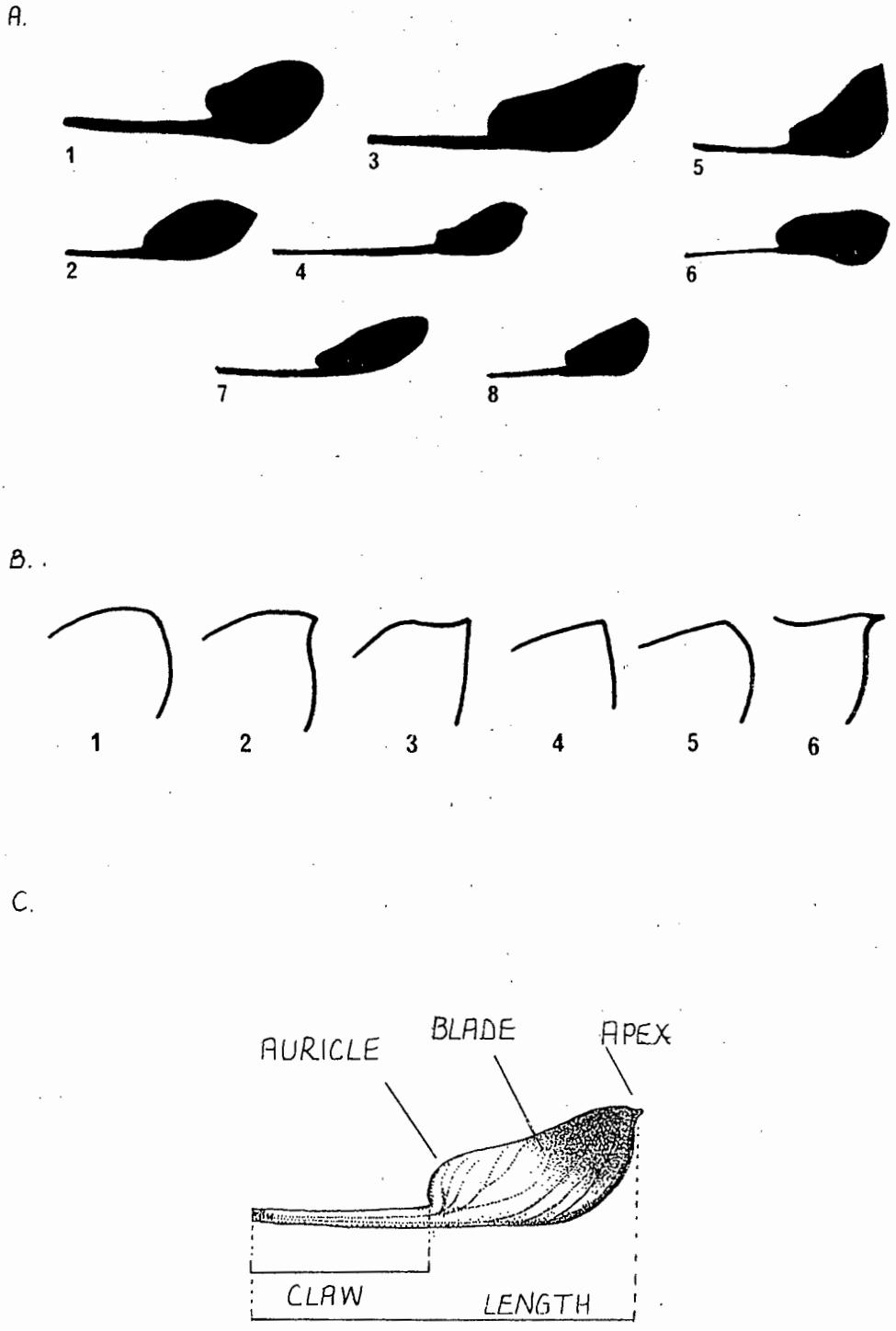


Fig. 2.17 Keel petals in *Otholobium*. **A**. Shapes of keel petals: 1, *O. arborescens*; 2, *O. polyphyllum*; 3, *O. wilmsii*; 4, *O. acuminatum*; 5, *O. accrescens*; 6, *O. bolusii*; 7, *O. fruticans*; 8, *O. argenteum*. **B**. Shapes of keel apices: 1, convex/convex; 2, convex/acuminate; acuminate/straight; 4, straight/straight; 5; straight/convex; 6, acuminate/acuminate. **C**. Keel petal of *O. wilmsii* showing different parts and points of measurement

2.3.2 **Calyx**

All taxa have a five-lobed campanulate calyx with or without fusion of the vexillar lobes (Fig. 2.18a). Three parts of the calyx are referred to in this study: calyx lobes, calyx teeth, and calyx tube (Fig. 2.18b). The fused portion of the calyx is called the calyx tube whereas the unfused portions are called the calyx teeth. The fused and unfused portion together are referred to as the calyx lobes. The lobes are measured from the apex of each tooth to the base of the tube directly beneath each tooth. Some authors treat lobes (as used here) synonymously with teeth. Calyx tubes may be shallow (*O. candicans* and *O. obliquum*) to quite deep (*O. acuminatum*).

Three types of calyx lobes have been distinguished (Examples referred to can be seen in Fig. 2.18a).

a. **Keel (carinal) lobe** - This lobe lies directly beneath the keel and is thus abaxial. It may be equal to or shorter than the other lobes. The teeth may be acute, pungent or acuminate. In some species the keel lobe is highly modified and diagnostic for the species, eg. *O. acuminatum* and *O. heterosepalum*.

b. **Lateral lobes** - There are two lateral lobes. These flank the sides of the flower and may be equal to or longer than the vexillar lobes.

c. **Vexillar lobes** - There are two vexillar lobes. These are situated behind the standard, each tooth flanking the reflexed standard. These lobes show various degrees of connation beyond the calyx tube. They can be almost fused as in *O. polyphyllum* or free as in *O. macradenium*, with various degrees of fusion occurring in other species. The teeth may be straight or falcate.

Fig. 2.18 Basic calyx types in *Otholobium*. 1, *O. arborescens*; 2, *O. macradenium*; 3, *O. obliquum*; 4, *O. carneum*; 5, *O. pictum*; 6, *O. spissum*; 7, *O. polyphyllum*; 8, *O. argenteum*; 9, *O. heterosepalum*; 10, *O. pungens*; 11, *O. venustum*; 12, *O.acuminatum*; 13, *O. rotundifolium*.

The calyx teeth may be all the same shape and size as in *O. macradenium* or they may be all different as in *O. obliquum*. Shape varies from linear, lanceolate, triangular to ovate.

The length, pubescence and degree of fusion of the calyx lobes; the shape and length (in relation to calyx tube) of the calyx teeth; and finally the ratio of the lobes to each other are all useful diagnostic characters.

2.3.3 **Androecium**

The androecium is the least variable floral character in *Otholobium* having few characters of diagnostic value. Nine of the ten filaments are fused variously into a sheath: split adaxially along its entire length; fused basally but free distally; or free basally and fused distally.

The fused stamens are referred to as a **staminal column** or **androecial sheath**. The tenth or vexillar stamen may be free from the androecial sheath, fused to the androecial sheath along its lower third or fused for more than half its length. Fenestrae may be absent or present at the base of the sheath.

The uniform anthers form two whorls when enclosed in the sheath as their alternate filaments vary in length; the short unfused portion bearing versatile anthers, the long unfused portion bearing basifixed anthers. Anthers dehisce longitudinally.

The androecium has not been included on any of the illustrations in Chapter 9 as there was not enough variation to record.

2.3.4 **Pistil**

The length of the pistil, degree of stipitation, degree of development of the entasis, vestiture and glandulosity are all useful taxonomic characters.

The ovary may be sessile, sub-sessile or stipitate. It is always uniovulate. The type and degree of vestiture on the ovary wall can be species specific, eg. *O. venustum* (glabrous), *O. heterosepalum* (glandular) and *O. spissum* (densely sericeous). Vestiture, if present, may be on the valves, or may extend along the style as far as the entasis.

The style is usually glabrous but in some species may be quite hairy (*O. polystictum*, *O. nigricans* and *O. rotundifolium*). There is a thickened region of the style, between the ovary and the stigma, called the **entasis**. The entasis may be broadest before, at or beyond the point of flexure or curvature of the style (Fig. 2.19). It is absent in *O. accrescens*, very thick in *O. obliquum* but in all other species it is moderately thickened.

The height of curvature is a useful character and is calculated as the vertical distance from the base line of the style to the level of the stigma (Fig. 2.19). The erect portion of the style may be perpendicular (most species), forward-sloping (*O. fruticans*, *O. gazense*, *O. heterosepalum*, *O. macradenium*, *O. polystictum*, *O. rotundifolium*, *O. saxosum*, *O. sericeum*, *O. wilmsii*) or incurved (*O. hamatum*).

The stigma is capitate and may be penicillate or glabrous.

2.3.5 **Fruits and seeds**

Fruit structure and morphology is very diagnostic for genera of the Psoraleeae (Fig. 2.20), but is not particularly useful for discriminating species within *Otholobium*

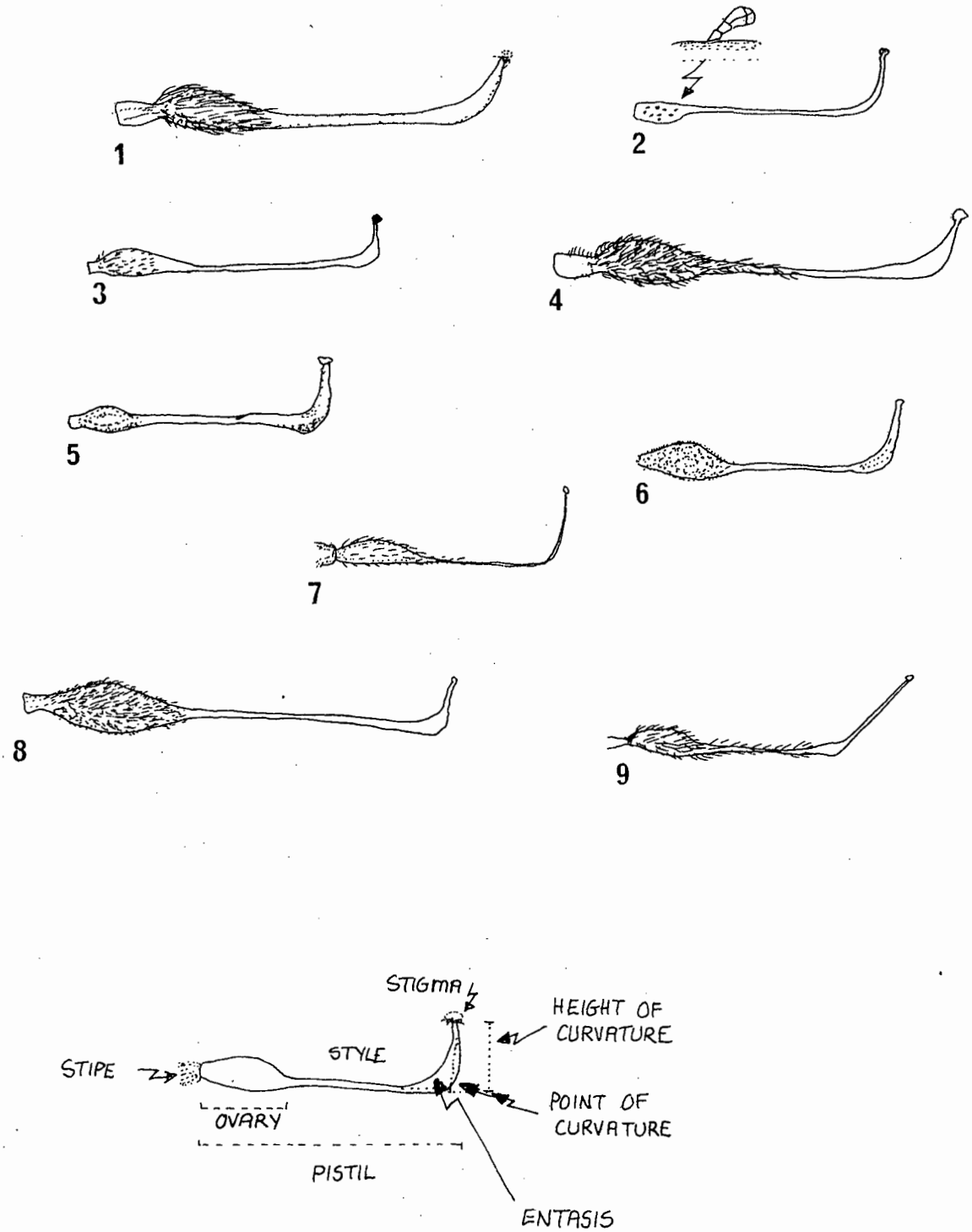


Fig. 2.19 Representative pistils of *Otholobium*. 1, *O. wilmsii*; 2, *O. sericeum*; 3, *O. stachyerum*; 4, *O. nigricans*; 5, *O. obliquum*; 6, *O. bracteolatum*; 7, *O. accrescens*; 8, *O. accrescens*; 9, *O. rotundifolium*.

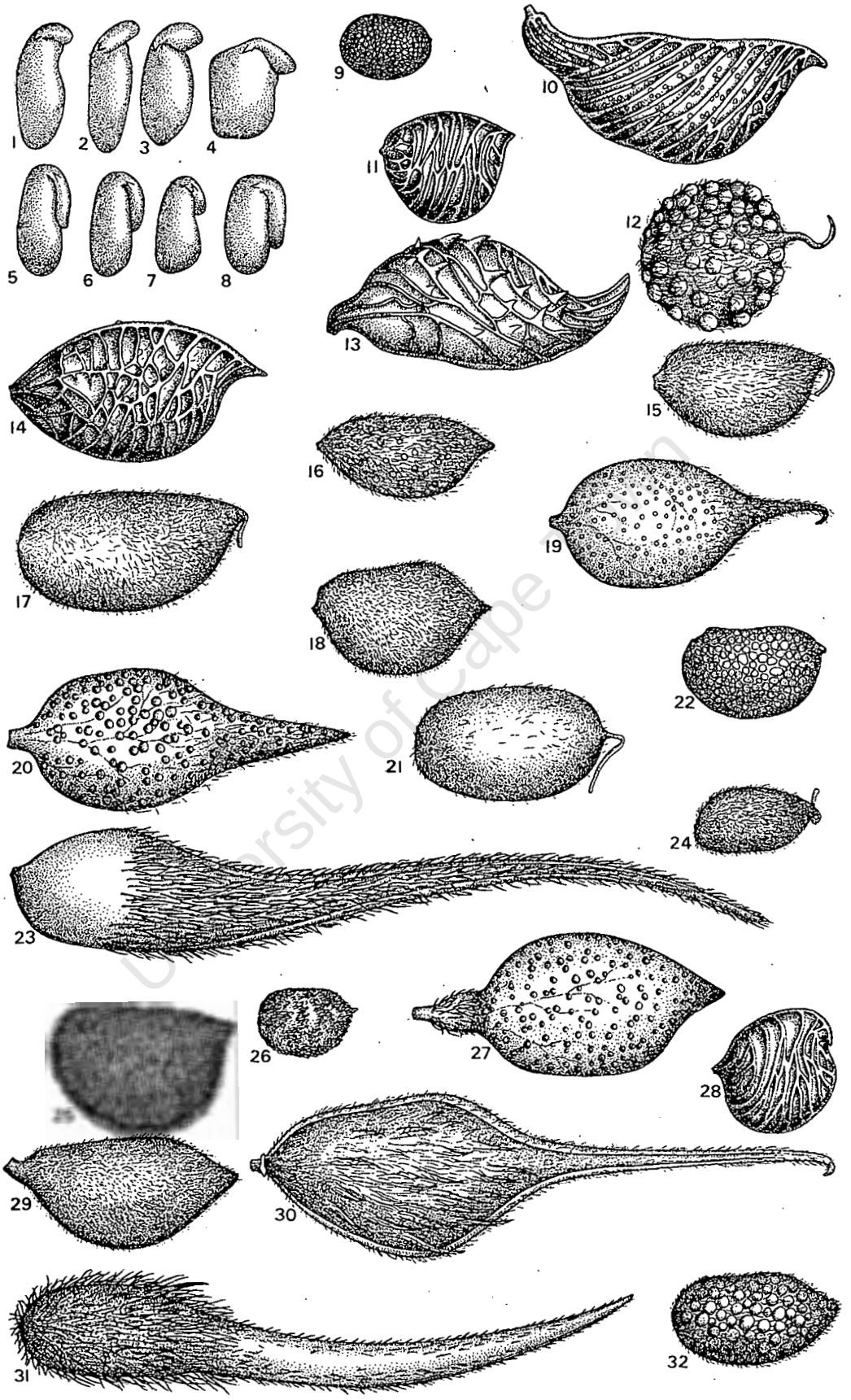


Fig. 2.20 A – Representative types of cotyledons (×1) in Amorpheae (1–4) and Psoraleeae (5–8); B – Representative types of fruits (×6) in Psoraleeae: 9 *Psoralea tenax (Cullen)*; 10 *P. lupinellus (Orbexilum)*; 11 *P. virgata (Orbexilum)*; 12 *P. micrantha (Orbexilum)*; 13 *P. melanocarpa (Orbexilum)*; 14 *P. onobrychis (Orbexilum)*; 15 *P. albida (Orbexilum)*; 16 *P. lasiostachys (Cullen)*; 17 *P. pubescens (Orbexilum)*; 18 *P. wilmsii (Otholobium)*; 19 *P. cuspidata (Orbexilum)*; 20 *P. canescens (Orbexilum)*; 21 *P. pinnata (Psoralea)*; 22 *P. corylifolia (Cullen)*; 23 *P. esculenta (Orbexilum)*; 24 *P. plicata (Cullen)*; 25 *P. drupacea (Cullen)*; 26 *P. plumosa (Cullen)*; 27 *P. tenuiflora (Orbexilum)*; 28 *P. eglandulosa (Orbexilum)*; 29 *P. foliosa (Otholobium)*; 30 *P. acaulis (Bituminaria)*; 31 *P. bituminosa (Bituminaria)*; 32 *P. pustulata (Cullen)*.

(Fig. 2.21) and *Psoralea*. In both genera the fruits are either papery or cartilaginous, with or without glands, and may be distinctly reticulate or without any surface markings. The mature fruits may be completely enclosed within the calyx, which in many species is accrescent, or they may be partially or scarcely enclosed within the calyx (*O. candicans* and *O. caffrum*).

The fruits of *Otholobium* are swollen, indehiscent, pubescent, slightly beaked, and single-seeded. Seeds are either concolorous (khaki-green, olive green, pale brown, dark brown, chestnut or black), or discolorous (with purple markings); longer than broad, somewhat compressed, dull or nitid, and mostly oblong or elliptic-oblong, All species have a recurved radicle in the seed.

2.3.6 **Discoid floral nectary**

Whilst discoid floral nectaries (intrastaminal nectariferous discs sensu Lavin, 1988) have been frequently reported in the Papilionoideae, particularly in the Phaseoleae (Waddle & Lersten, 1974), their presence in the Psoraleeae is unreported; probably because of their small size.

Fig. 2.22 shows a discoid floral nectary in *Otholobium thomii*. This type of nectary occurs in all of the species which I have studied in the fresh state. It is not apparent from the dissection of flowers resuscitated from herbarium specimens. The nectary is a circular flange of tissue that surrounds the base of the pistil. There is some variability in the size of the nectary in different species but this is not taxonomically significant.

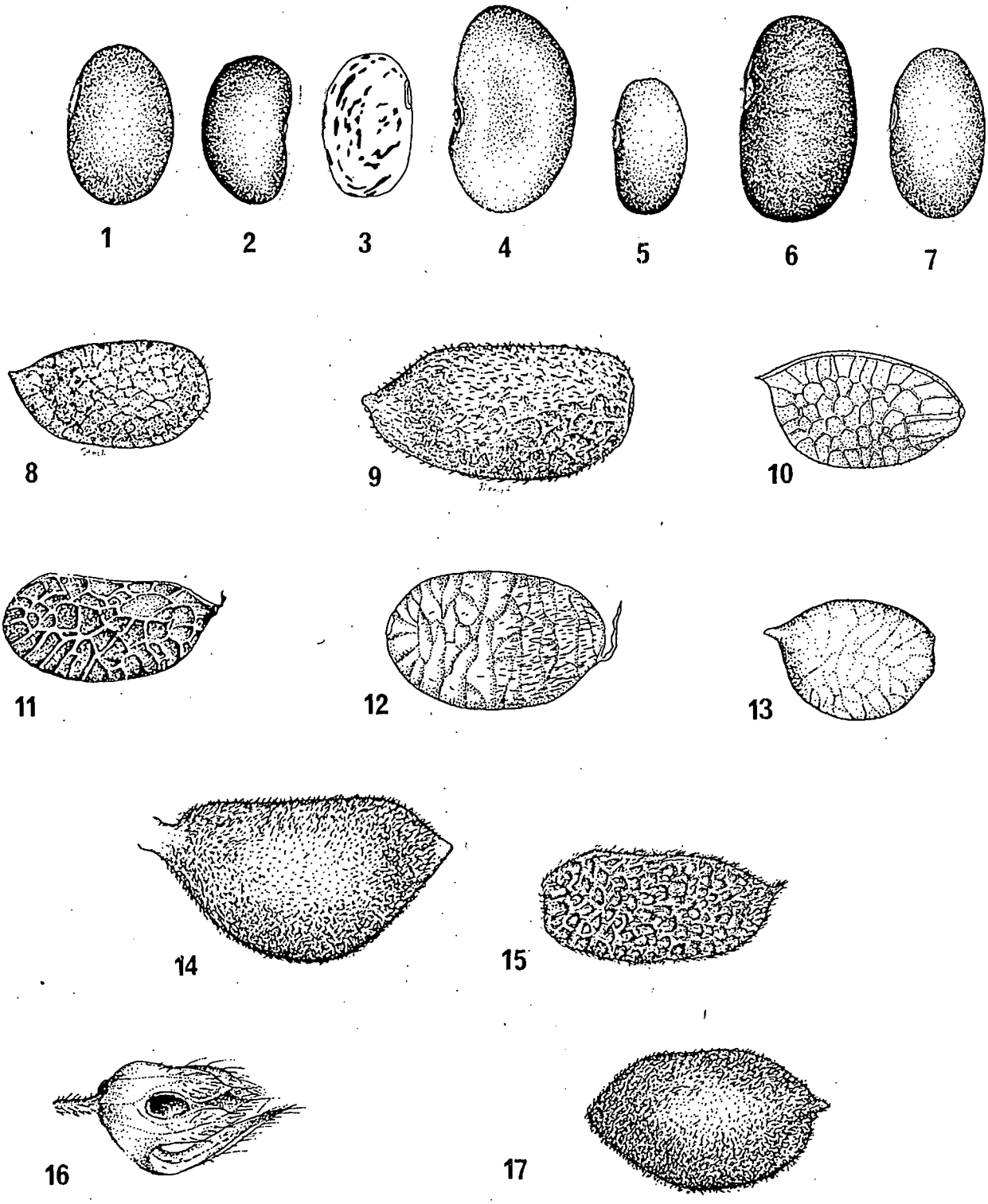


Fig. 2.21 Representative seeds and fruits of *Otholobium*. **1-7**. Seeds. 1, *O. fruticans*; 2, *O. wilmsii*; 3, *O. hirtum*; 4, *O. nigricans*; 5, *O. stachyerum*; 6, *O. striatum*; 7, *O. flexuosum*. **8-17**. Fruits. 8, *O. stachyerum*; 9, *O. bracteolatum*; 10, *O. foliosum*; 11, *O. caffrum*; 12, *O. hirtum*; 13, *O. carneum*; 14, *O. caffrum*; 15, *O. striatum*; 16, accrescent calyx of *O. obliquum*; 17, *O. nigricans*.

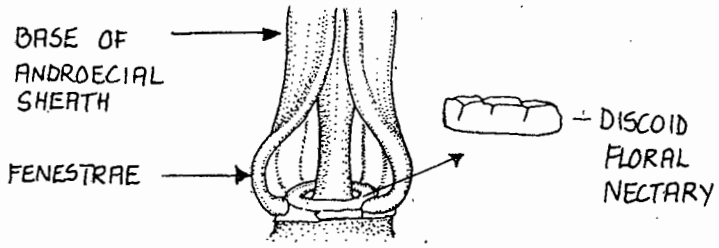


Fig. 2.22 Discoid floral nectary of *Otholobium thomii*. Note the fenestrae formed by a flaring and lack of fusion of the basal part of the androecial sheath. This nectary is typical of the genus; although in some species the nectaries are minute.

CHAPTER 3

CYTOLOGY

Contemporary systematists are now familiar with recent karyological evidence that points to highly variant genomes among higher plants, not only with regard to the structure and number of chromosomes but also genome size, expressed in pg DNA or number of base pairs (Greilhuber, 1984).

Infrageneric variation of nuclear DNA is more restricted than found in higher taxa but is still diverse enough to be of taxonomic importance (Bennett & Smith, 1976; Bennett, 1983). Recent acceptance of the "fluidity" of plant genomes has transformed our thinking from a karyological worldview of genes with fixed chromosomal positions and evolution occurring slowly by the accumulation of point mutations to one of rapid genomic change, sometimes elicited by environmental stresses. These ideas are discussed in more detail in the symposium organised by Clegg (1987) and in Zurawski & Clegg (1987).

Recent reviews of all aspects of chromosomal morphology, anatomy and behaviour in the Leguminosae have been provided by Goldblatt (1981), Rees and Narayan (1981) and Doyle (1987). These authors stress the tremendous technical and theoretical strides which have taken place in the last few years and which, problems of homoplasies

aside, promise to have a fundamental impact on phylogenetic studies of legumes. Unfortunately, as Doyle (1987) and Rees and Narayan (1981, 1988) stress, most of this work has been carried out predominantly on cultivated genera: 1, DNA amounts - *Lathyrus*, *Phaseolus*, *Vicia*; 2, chloroplast DNA (cpDNA) - *Lathyrus*, *Phaseolus*, *Pisum*, *Vicia* and *Vigna*; 3, mitochondrial DNA (mtDNA) - *Glycine*, *Hedysarum*, *Medicago*, and *Vicia*. However, there is every hope such studies will be extended in the near future to other tribes, particularly those of primitive legumes (Stirton, 1987). While chromosome counts may be useful in some circumstances there is today increasing reservation about their usefulness in some plant groups; often with many closely related genera having the same number of chromosomes. This is especially a feature of most of the advanced tribes of Papilionoid Leguminosae (Goldblatt, 1981).

The tribes Psoraleeae (x=11) and Amporpheae (x=10), for the most part, have different base numbers. A list of all known chromosome counts of the Psoraleeae are listed in Table 3.1. Because of the uniform numbers found in both tribes it was decided to leave a cytological investigation of the African Psoraleeae to a later date. However, basic chromosome number has been used as a character in the cladistic analysis of the genera. Both *Psoralea* and *Otholobium* have 2n=11.

Samanta and Datta (1975) have provided the first example of different chromosomal biotypes in the Psoraleeae. They found that *Cullen corylifolia* (L.) Medik (*P. corylifolia* L.) had three cytotypes (2n = 20, 22, 24) and that the chromosomal differences are related to morphological differences: length and breadth of the leaf lamina, palisade ratio, stomatal index, abundance of glands and hairs, and length of hairs and stomata. What is somewhat surprising is their interpretation that the phylogenetic sequencing proceeds 2n=24 -> 2n=22-> 2n=20. X=11 is usually considered to be the base number of the tribe. A recent count of 2n=24 by Tuteja and Bhatt (1984) confirms

Table 3.1 Published chromosome numbers in the Tribe Psoraleeae.

Genus / Species	n	2n	References
1. Bituminaria			
bituminosa	10		Turner in Ockenden 1965
		20	Khozuharov, Kuzmanov & Markova 1972
		20	Van Loon 1974, 1980
		20	Kreuter 1930, 1935
		20	Tschechow 1930, 1935
		20	Larsen 1960
		20	Fernandes & Queiros 1978
		20	Natarajan 1978
2. Cullen			
americana		22	Fernandes & Queiros, 1978
corylifolia	9		Sakar, Datta & Chatterjee 1972
	10		Malla, Bhattari, Gorkhali, Saiju & Singh 1977
		20	Samanta & Datta 1975
		20	Datta & Maiti 1968
		20	Thombre 1959
		20	Subramanian 1972
		22	Bakale & Sharma 1982
		22	Ma, Qin & Xing 1984

Table 3.1 Continued

Genus / Species	n	2n	References
2. Cullen			
corylifolia		22	Samanta & Datta 1975
		22	Raghaven 1959
		24	Samanta & Datta 1975
		24	Tuteja & Bhatt 1984
drupacea		22	Podlech & Dierterlen 1969
eriantha		22	Delacy & Britten 1970
palaestina		20	Kreuter 1929, 1930
plicata	11		Baquar & Husain 1967
sp.	11		Keighery 1978
3. Orbexilum sensu lato (American Psoraleeae)			
argophylla		22	Love & Love 1982
		22	Ledingham 1957
californicum	11		Raven, Khyos & Hill 1965
cinerea	11		Turner in Ockenden 1965
cyphocalyx		22	Turner 1956
esculenta		22	Love & Love 1982
		22	Ledingham 1957
digitata		22	Turner 1956

Table 3.1 Continued

Genus / Species	n	2n	References
graveolens	11		Turner in Ockenden 1965
glandulosa		20	Kreuter 1930
higuerilla		22	Di Fulvio 1971
hypogaea		22	Turner 1956
lanceolata	11		Raven, Khyos & Hill 1965
		22	Ledingham 1957
latestipulata	11		Turner in Ockenden 1965
macrostachya	11		Raven, Khyos & Hill 1965
		20	Kreuter 1930
patens	11		Turner in Ockenden 1965
physodes	11		Raven, Khyos & Hill 1965
psoraleoides	11		Turner in Ockenden 1965
rhombifolia		22	Turner 1956
subacaulis	11		Baskin & Caudle 1966
	11		Baskin & Quarterman 1965
subulata	11		Turner in Ockenden 1965
tenuiflora	11		Raven, Khyos & Hill 1965
4.Otholobium			
fruticans		22	Goldblatt 1981

that different cytotypes exist in *Cullen corylifolia*, a widespread weed and widely cultivated medicinal plant. For the cladistic analysis I have scored the genus *Cullen* as x = 10, these anomalous counts notwithstanding.

CHAPTER 4

PHYLOGENETIC ANALYSIS

4.1 Introduction

One of the milestones in the history of comparative biology and evolutionary science was the publication of Willi Hennig's 1950 book *Grundzüge einer Theorie der phylogenetischen Systematik* (Janvier, 1984).

Hennig (1950, 1966) proposed an objective method for reconstructing phylogenies (genealogies of organisms) and establishing classifications reflecting those phylogenies (Crisp & Weston, 1987). I will refer to his technique as **Cladistics** and the resulting branching diagrams as **cladograms**. Hennig's ideas and influence on modern systematic thought have been profound and wide reaching, though not without considerable controversy (Dupuis, 1978; Hull, 1979; Nelson & Platnick, 1981; Wanntorp, 1980) and often humour (Filo G. Neticks. 1978).

Central to Hennig's method is his concept of a **monophyletic group**; a group descended from a single ('stem') species and inclusive of all the species descended from the stem species. Such groups are recognised by the shared possession of all its members of one or more evolutionary novelties, ie. **synapomorphies**. The strategy of cladistic analysis should therefore be the recognition of synapomorphies.

Brundin (1972), one of Hennig's earliest supporters, has gone as far as to say that Hennig's contributions will one day be seen as "one of the major methodological advances on causal biology after Darwin".

Not all of Hennig's critics would agree (Van Valen, 1979) with Brundin but even some of the most vociferous have acknowledged that while they cannot agree with his translation of cladograms directly into classifications they do consider his method of cladistic analysis an "important contribution" to systematic methodology (See Mayr, 1974; Cronquist, 1987). Some more recent critics of the field have been less generous (Meeuse, 1981; Halstead, 1982). Humphries and Chappill (1988) provided a critical response to Cronquist's (1987) reservations and his "vehement and wide-ranging attack on cladistic methodology". But not all are absorbed in the debate. Cohen (1985) in his fascinating book *Revolution in Science* never mentions Hennig's name or ideas once. Perhaps scientific histiography needs scientists to inform it of what and whom could be important!

Coomans (1983) has suggested that Hennig's "Phylogenetischen Systematik" has been so successful because it alone of the various methods of systematic analysis is the "*only approach based on biological evolution that can be studied by a scientific (hypothetico-deductive) comparative method*". Gaffney (1979) and Kiriakoff (1960) provide a useful background to this debate. Sattler (1987) offers one of the most readable and critical analyses of the hypothetico-deductive approach to science and is a good antidote to simplistic Popperianism (as much paraded by some "articulate" cladists). Cartmill (1981) goes as far to say that *"the study of phylogeny does not qualify as a science under the demarcation criterion of Popper"* and further that *"... supposed falsification procedures constructed by Popperian biologists for use in testing phylogenetic hypotheses incorporate either non-sequiturs or demonstrably false premises or both"*. The parsimony criterion however has value in choosing among conflicting phylogenetic hypotheses. Koningsveld (1982) in his book *Het Verschijnsel Wetenschap* also provides a useful comparative summary of Popperianism and its rival approaches. It is perhaps instructive that

much of the debate taking place in Systematics lacks historical perspective and suffers from a want of insight into the roots of many of the core ideas; easily discernible from reading "perspective" authors such as Riedl (1986).

The fundamentals of cladistics have now been expounded exhaustively in the literature, some being more readable and comprehensible than others (Farris, Kluge & Eckhardt, 1970; Kavanaugh, 1972; Funk & Stuessy, 1978; Cracraft & Eldredge, 1979; Cracraft, 1979; Eldredge & Cracraft, 1981, Wiley, 1981; Dahlgren & Rasmussen, 1983; Duncan & Stuessy, 1984; Ax, 1987). There is much scope for a modern definitive text on all aspects of cladistics. All of these books have a strong bias towards one or other of the emerging schools of thought within cladistics and so are scarcely objective in providing the novice with a balanced overview.

New "circles" within cladistics - **neocladistics** or **numerical cladistics** (Cartmill, 1981), **transformed** or **pattern cladistics** (Beatty, 1982), and **evolutionary cladistics** (Hill & Camus, 1986) have begun to rupture the placidity of the initial consensus which united all "cladists" against pheneticists and evolutionary systematists. This shows that the discipline has reached maturity and is nearing the steady state of its bandwaggoning phase.

The current controversies in cladistics, bizarre as they may seem to some outsiders, are more than just clashes of determined personalities (see Farris, 1985; Saether, 1986). They concern some deeply held beliefs and offer serious challenges to accepted notions of the unit of species, the relevance of falsification and parsimony, ontogeny versus outgroup analysis, and the relationship between formal language and formal systematic analysis; to name a few. Typical of such exchanges are Brooks and Wiley's (1985) attempt to show that "pattern cladistics stands in relationship to phylogenetic systematics as part to a whole", ostensibly based on a cue from Platnick and Cameron (1977), but greeted by Platnick (1986) as "pure puffery". Farris's (1985) paper, based on

his Presidential Address, must stand as a landmark for future sociologists of science as it encapsulates, far more articulately and less aggressively than the spoken occasion (at which a number of dinner attendees stormed out vociferously), the heart of the controversies within cladistics. As Humphries and Chappill (1988) put it *"the two principles of monophyly and parsimony have been independently discovered by molecular biologists, zoologists and linguists. Rather than being a bandwagon, cladistics has arisen through a gradual refinement of methods determining the relationships of taxa within a framework of Darwin's general theory of evolution (descent with modification)."*

The above comments and observations notwithstanding there is a growing list of well researched and elegantly executed analyses of plant groups using cladistic methods, whatever their algorithmic and empirical bases. In my analysis of generic relationships within the tribe Psoraleeae and within *Otholobium* I shall be adopting broadly the methods outlined by Humphries and Funk (1984) and used in two major cladistic analyses of legumes (Crisp and Weston, 1987; Lavin, 1987) published in Stirton (1987) and Lavin (1988). I refer the reader to the concepts and general methods outlined in the above papers.

4.2. **Nature of cladistic data**

The underlying principles of monophyly, synapomorphy and parsimony are undoubtedly important to phylogenetic analysis, but as Pimental and Riggins (1987) point out these issues become meaningless if the data used in the analysis is, as they feel it is in many cladistic studies, of inferior quality. What then are valid cladistic data and how should they be coded as variables?

4.2.1. **What are cladistic data?**

Pimental and Riggins (1987) define cladistic data as records of the characters of the organisms being studied; characters being features of organisms that can be evaluated as variables with two or more mutually exclusive and ordered states. Order and independence are intrinsic features of the definition and are based on two underlying assumptions: 1, that the organisms are the ingroup and the outgroup of any given study, and 2, that the characters are intrinsic features that have homologous states among those organisms. They stress that "character" must translate to include all homologous expressions of a feature found in the ingroup and the outgroup. The data derived from such characters are referred to as **multistate** or **cladistic variables**. A character should correspond to a **morphocline** and its multistate variable representation to a **transformation series.**

It is important when selecting characters to ensure that character states are not used as separate and independent characters as it presumes that any character state can be transformed into any other (Mickevich, 1982) and may also lead to multiple equally parsimonious solutions thereby increasing the number of equally parsimonious trees which have to be finally evaluated. Another reason is that as each state becomes equivalent to a two-state variable, the multistate character is effectively weighted more strongly thereby introducing redundancy into the data (Pimental & Riggins, 1987).

Mickevich (1982) recognized two primary types of multistate characters (variables): **additive** and **non-additive**. An **additive variable** has a linear sequence of states (**ordinal variable**). A **non-additive variable** has states ordered in a branching pattern. Numeric coding of cladistic data can be multistate (sequential numbering), additive binary, or non-additive binary (0, 1 designations). The pros and cons of using these different types of coding are discussed in Pimental & Riggins (1987) and based on the arguments provided therein and on the constraint of having only one computer algorithm available to me I have decided to use ordinal coding only. Furthermore, following Nel-

son (1978) and Patterson (1982) I will only use absence as a cladistic variable if absence is a derived condition or if it is part of a multistate sequence. If more than one state (character variability) occurs in a taxon I will treat the taxon as two terminal taxa. I will use a few discontinuous quantitative variables in the analysis, for example chromosome number, but neither continuous quantitative variables nor ratios of any kind will be used.

Having selected characters and determined character states to use one needs to be able to assign **evolutionary polarities** (**apomorphous** or **plesiomorphous**) to the character states. Janvier (1984) summarises succinctly the five major criteria which one could employ to do this: **Out-group rule (Argumentation scheme)**, **Progression rule**, **Palaeontological argument**, **Transformation series criterion**, and finally the **Ontogenetic criterion**. I will now discuss the applicability and use of these five criteria in the present analysis. A detailed analysis of these criteria is to be found in Wiley (1981).

4.2.1.1. **Out-group rule**

The **argumentation scheme** or **out-group rule** involves a search for homologous characters in the sister group of the monophyletic group (Hennig, 1966; Platnick, 1979; Watrous & Wheeler, 1981; Maddison, Donoghue & Maddison, 1894). As Humphries & Funk (1984) put it the rule "serves two functions; checking the validity of particular characters as homologies or synapomorphies and determining their distribution". Presence in the sister group implies that they are plesiomorphous for the monophyletic group under consideration. Absence in the sister group implies that they are unique in the monophyletic group and hence apomorphous to it.

The application of this rule has been controversial and has generated considerable debate (De Jong, 1980; Stevens, 1980; Watrous and Wheeler, 1981; Wiley, 1981; Humphries and Funk, 1984; Nelson, 1978). It is problematic when characters of the study group are absent from the outgroup and when the outgroup cannot on current knowledge be determined. Both these problems occur in the present study but only the latter is a real problem and will be discussed next.

(i) **Search for a taxonomic out-group**

The tribe Psoraleeae has until recently (Barneby, 1977; Stirton, 1981b) been difficult to delimit. No one has been able with any confidence to align it with other tribes. The different tribal relationships suggested by various authorities are summarized in Table 4.1. There have been no suggestions in the literature as to what the outgroup of Psoraleeae might be. However, based on evidence led in Chapter 2 the following tribes may represent outgroups of the Psoraleeae: Desmodieae, Indigofereae, Trifolieae and Dalbergieae.

4.2.1.2 **Progression rule**

Hennig's (1966) secondary accessory criterion, also called the **progression rule**, states that the more primitive taxa of a group are found nearer the origin of the group than are derived ones. Although Hennig originally proposed this rule from his dispersalist view of Darwinian biogeography it is today viewed in terms of vicariance biogeography (Nelson, 1975; Brundin, 1981).

4.2.1.3 **Transformation series criterion**

Hennig's third accessory criterion, called the **transformation series correlation**, concerns, according to Janvier (1984), comparisons of successive states of different transformation series of characters. This is an extension of the **test of homology congruence** (Patterson, 1982) which suggests that when a majority of homology (=synapomorphy) distribution patterns are congruent, the probability that each pattern provides a good hypothesis of character state polarity is greater.

4.2.1.4 **Ontogenetic criterion**

The ontogenetic criterion is considered by transformed cladists to be the only really reliable criterion by which to evaluate polarities. It concerns the order of appearance of characters or character states during the ontogeny of organisms (Patterson, 1982; Lovtrup, 1974), i.e. the most apomorphous characters are the most particular, or restricted to the smallest number of organisms.

4.3 **Phylogenetic methods**

Methods of phylogenetic inference fall into one of either two major categories: **parsimony** or **compatibility** methods. Seborg (1988) provides a succinct summary of the main differences between these methods. Felsenstein (1982) has shown that given a data-set without homoplasies that both methods will produce similar phylogenetic hypotheses but that they will differ significantly in how they resolve homoplasies.

Seborg (1988) summarises the differences as follows:

"Parsimony methods minimize the number of character state transformations, or alternatively the number of ad hoc hypotheses needed to explain the observed character state distribution." Hendy and Penny's (1982) branch and bound algorithm applies a special search strategy to find the shortest tree, but it is unsuitable for large data-sets like *Otholobium*.

"Compatibility methods base the phylogenetic hypothesis only on the largest group of compatible characters or largest clique (clique analysis)."

The transformed cladistic belongs here (Ladiges, Humphries and Brooker, 1983).

Fink (1986) has made a thorough analysis of the different parsimony and compatibility computer algorithms available and concluded that PAUP was superior to the other packages. This is fortunate as it is the only package which was available to me and so was used in the generic analysis.

4.4 Previous cladistic studies in Leguminosae

There have been very few cladistic studies in the legumes. The earliest phylogenetic studies were the valuable macromolecule sequencing studies of Boulter and his co-workers (Boulter, 1981). Their recent work, with its indication that Brassicaceae is more closely related to the Leguminosae, is less convincing (Martin, Boulter & Penny, 1985).

The study of DNA fragments in Leguminosae (referred to in Chapter 3), produced using restriction endonucleases, has been recently reviewed by Doyle (1987). However, only Palmer, Jorgenson and Thompson (1985), studying cpDNA of *Pisum*, have used a cladistic algorithm to produce a rooted tree from which they concluded that one cultivar of the garden pea had originated independently from the others.

The remaining cladistic analyses in Leguminosae have all been produced within the last six years and vary considerably in their methods and complexity: *Leptosema* (Crisp, 1982); Millettieae (Geesink, 1984 {reviewed by Bremer, 1985}; Zandee & Geesink, 1987); *Taverniera* (Thulin, 1985), Robinieae (Lavin, 1987); Brongniartieae, Mirbelieae and Bossiaeeae (Crisp & Weston, 1987) and *Coursetia* (Lavin, 1988).

Of these studies only those of Crisp and Weston (1987) and Lavin (1988) gave reasonably resolved cladograms. Lavin studied 21 taxa and Crisp and Weston 66 taxa. Crisp and Weston had access to the Farris (1970) and Colless (1984) packages so were able to resolve their taxa into "families" which they could then study using PAUP. This procedure was not possible in this study. The analysis of *Otholobium* was abandoned after many attempts using different subsets of taxa and adding other taxa until the program could not add any more efficiently (very long run times). Various internal options using simple rooting, MULPARS, Farris optimization, branch and bound, and local and global branch swapping were employed.

4.5 **Characters used in generic analysis**

Table 4.1 lists the characters used in the analysis of generic relationships in the tribe Psoraleeae using PAUP version 2.3.2 (Phylogenetic Analysis USING Parsimony, David Swofford): global mulpars and Farris optimization generated 30 equally parsimonious trees of 24 steps and a consistency index of 0.708.

Table 4.1 Character list: Main data set (Zero scores are given to plesiomorphous states; higher scores indicate relative apomorphy).

1. **Chromosome base number** (CHROMNO): (0) 10; (1) 11.

2. **Leaf reduction** (LFSCALES): (0) foliolate leaves present in the adult plant; (1) leaves reduced to scales. Evidence for the reduction of leaflets to scales comes from seedling studies and was discussed in Chapter 2.

3. **Leaflet margins** (LFMARGIN): (0) entire; (1) crinkled/undulate.

4. **Leaflet blades in cross-section**: (0) flattened; (1) rounded and grooved.

5. **Leaflet apices** (LEAFAPEX): (0) straight; (1) recurved mucronate.

6. **Number of leaflets** (LFREDUCT): (0) 3; (1) 5-11; 2) 1.

7. **Leaf cavities** (LFGLANDS): (0) present; (1) absent.

8. **"Psoralea" (pseudoraceme) type of inflorescence** (FASCICLE): (0) absent; (1) present.

9. **Primary basal bracts of the peduncle** (PEDBRACT): (0) solitary, ovate to oblong; (1) paired, free filiform.

10. **Cupulum** (PEDICEL): (0) absent 2) present.

11. **Colour of hairs on inner lobes of calyx teeth** (CALOBES): (0) white; (1) black.

12. **Appendages on the standard** (STDAPEND): (0) undeveloped; (1) strongly developed.

13. **Ovary** (OVARY): (0) hairy; (1) glandular.

14.**Fruit texture** (FRUITEXT): (0) woody; (1) cartilaginous; 2) crustose, densely glandular; 3) membranaceous.

Table 4.2 Data matrix of 14 characters by 12 OTUs of Psoraleeae.

*Data file of Psoraleeae worldwide using PAUP Version 2.4.

!Parsimony analysis of Psoraleeae worldwide.

10 14

Psoralea1 11000011011110
Psoralea2 11010011011110
Hallia 10002101010110
Otho1 10010000100000
Otho2 10010001110101
Bitumina1 00000000100001
Bitumina2 00100000100001
Cullen1 10100000100003
Cullen2 10100000100103
Orbexil1 00000000100001
Orbexil2 00000000100002

4.6 Generic cladogram of Psoraleeae

Fig. 4.1 represents the cladogram which on current knowledge would seem to be the best interpretation of phylogenetic relationships in Psoraleeae worldwide, given that apart from *Otholobium* which has been monographed recently the other genera have not been revised from between 40 to 100 years. As such it is suggestive of relationships but may well have to be modified once accurate data is available from extra-African genera.

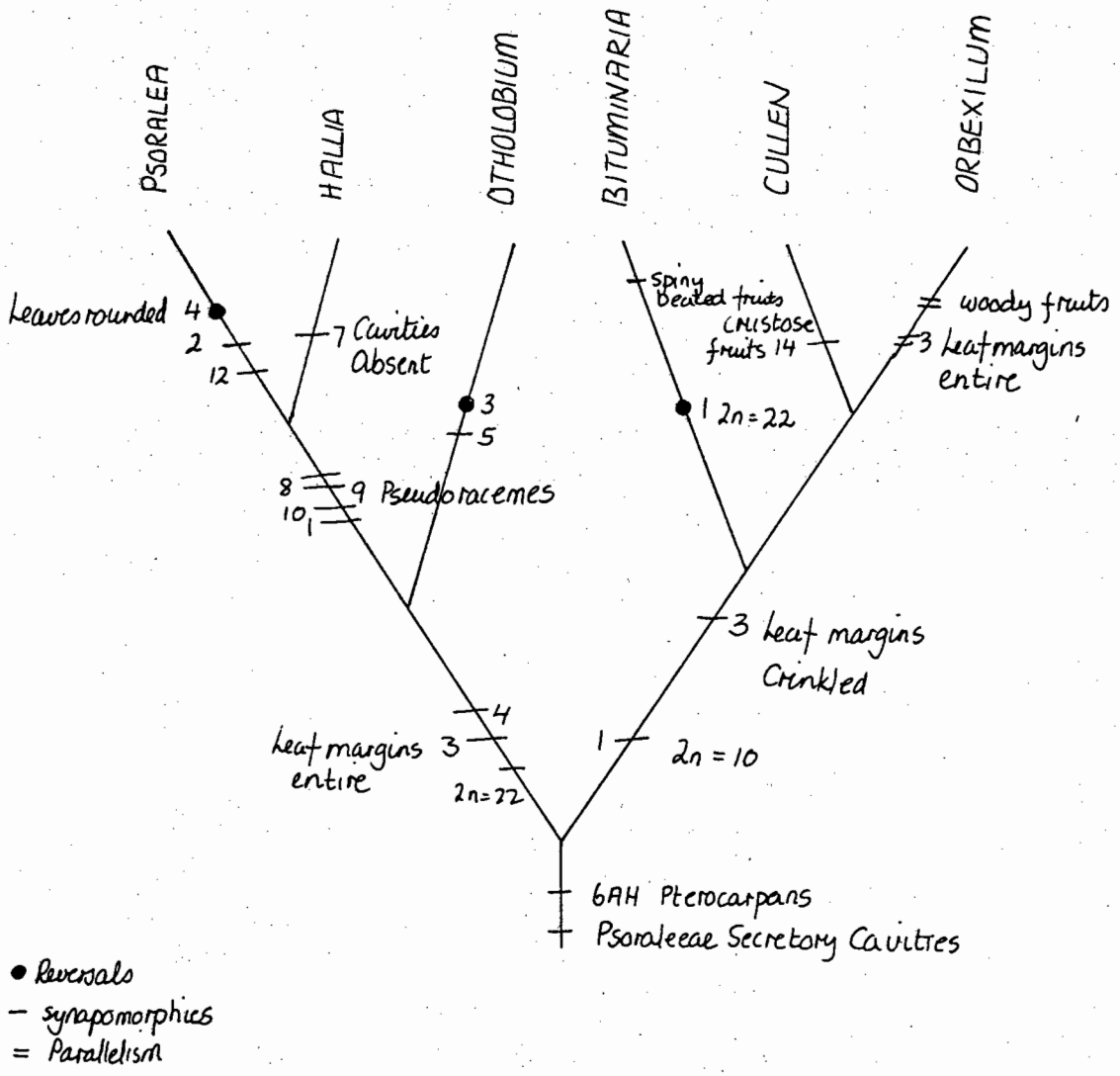


Fig. 4.1 Preferred cladogram of Psoraleeae sensu stricto.

CHAPTER 5

GEOGRAPHICAL DISTRIBUTION

5.1 Introduction

The majority of the species accepted in this revision fall within the domain of the Cape Floral Kingdom, or Capensis, but there are notable exceptions. It is therefore the intention of this chapter to attempt to: 1, discuss in general terms the distribution patterns of *Otholobium*; 2, resolve anomalous distribution patterns within the genus; and 3, determine whether *Otholobium* is an element of Capensis sensu Taylor (1978a).

The Cape Floral Kingdom, as defined by Takhtajahn (1969) and Good (1974), has one of the richest floras per unit area in the world; one estimate is that 8,550 species or 43% of the southern African flora occurs in 89,000 km² (Goldblatt, 1978). Much has been written about the origin, composition, structure and distribution patterns of this Kingdom (Marloth, 1908, 1915; Adamson, 1948, 1958; Levyns, 1938, 1952, 1964; Taylor, 1978a, 1978b, 1980; Goldblatt, 1978; Axelrod & Raven, 1978; Oliver, 1977; Oliver, Linder & Rourke, 1983). The relationship of Capensis (Taylor, 1978a) to the Afromontane and Afro-alpine floras has been discussed by many authors (Chapman & White, 1970; Dyer, 1966; Hedberg, 1963; Hilliard, 1978; Hilliard & Burtt, 1987; Killick, 1978; Levyns, 1952; Morton, 1972; Weimarck, 1933, 1936, 1940, 1941; Wild, 1964, 1968, 1975; White, 1978) and will not be repeated here except where it is relevant to the analysis of distributions in *Otholobium*. The dispersalist / vicariance models underlying these debates are discussed in Poynton (1983). Recent computer analyses of plant distributions in Africa have suggested that these methods might be useful to employ in future studies once more data becomes available (Denys, 1980; Oliver, Linder & Rourke,

1983).

5.2. Methods

Maps were compiled from vouchered herbarium specimens and coded according to the grid reference system of Edwards and Leistner (1971; for an explanation see Chapter 9). These vouchers may be consulted under the cited specimens of each species account. A large proportion of these localities were checked in the field. The distribution dots in the maps were placed as accurately as possible within each $\frac{1}{16}$ division of a 1° square, rather than placing the dot in the centre, as is usual practice.

5.3. Total distribution of *Otholobium*

The total distribution range of *Otholobium* is shown in Fig. 5.1. The greatest concentration of species is found in the Cape Province of South Africa, with two species extending beyond the Republic's borders to Zimbabwe, Malawi, Tanzania and Kenya. The genus does not reach Ethiopia. The eastern African species exhibit marked disjunctions, usually being restricted to mountain peaks. The overall distribution pattern is similar to that shown to occur in a wide range of genera: *Euryops* (Nordenstam, 1969) and Disinae, Orchidaceae (Linder, 1983) being two examples. However, unlike many of these genera *Otholobium* is absent from Madagascar and West Africa.

Otholobium exhibits a pattern of decreasing species richness and endemism as one moves from Capensis northwards. This fits the pattern found in many "Cape genera" (Baker & Oliver, 1967; Brenan, 1978; Goldblatt, 1978; Rourke, 1980).

Fig. 5.2 shows the known distribution of *Otholobium* in southern Africa whereas Fig. 5.3 shows the number of species per one degree grid square for the same area. Only

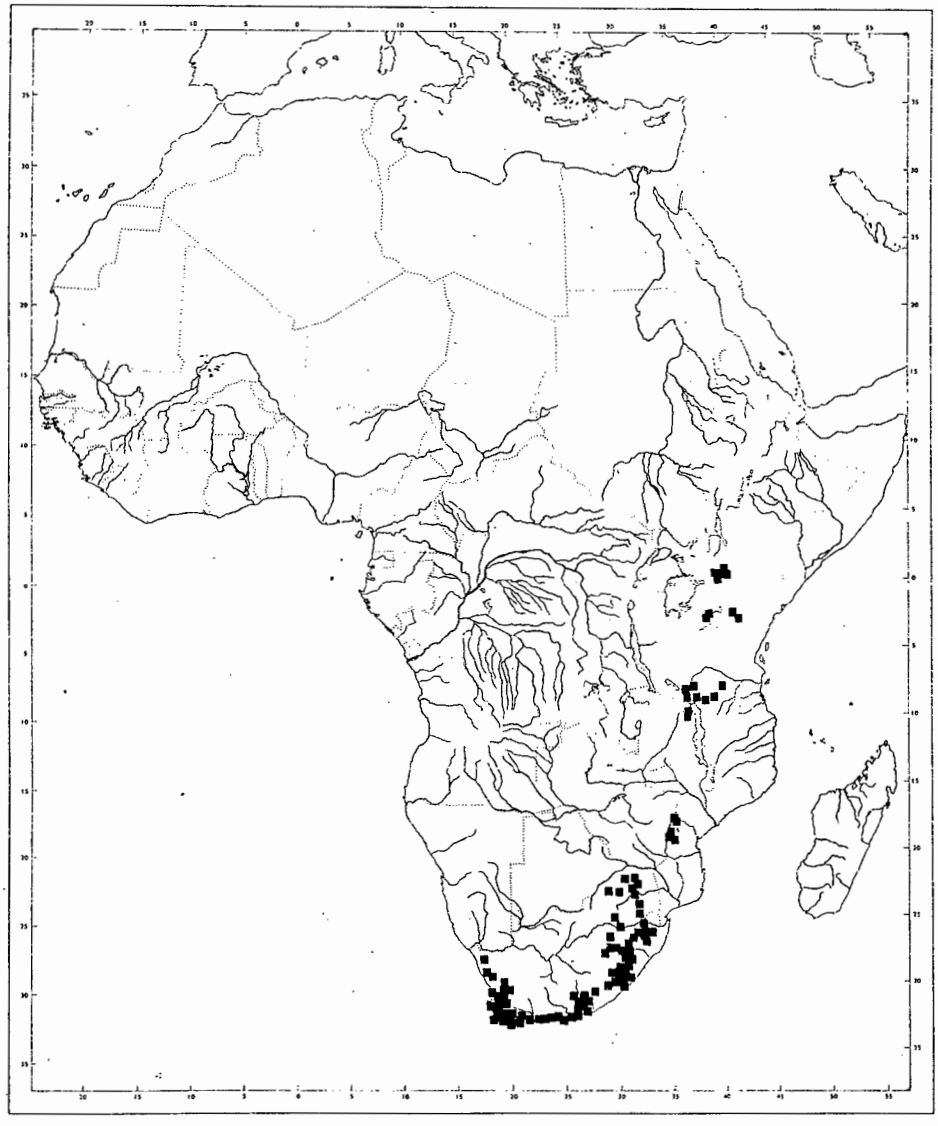


Fig. 5.1 Known distribution of the genus *Otholobium* C.H. Stirton.

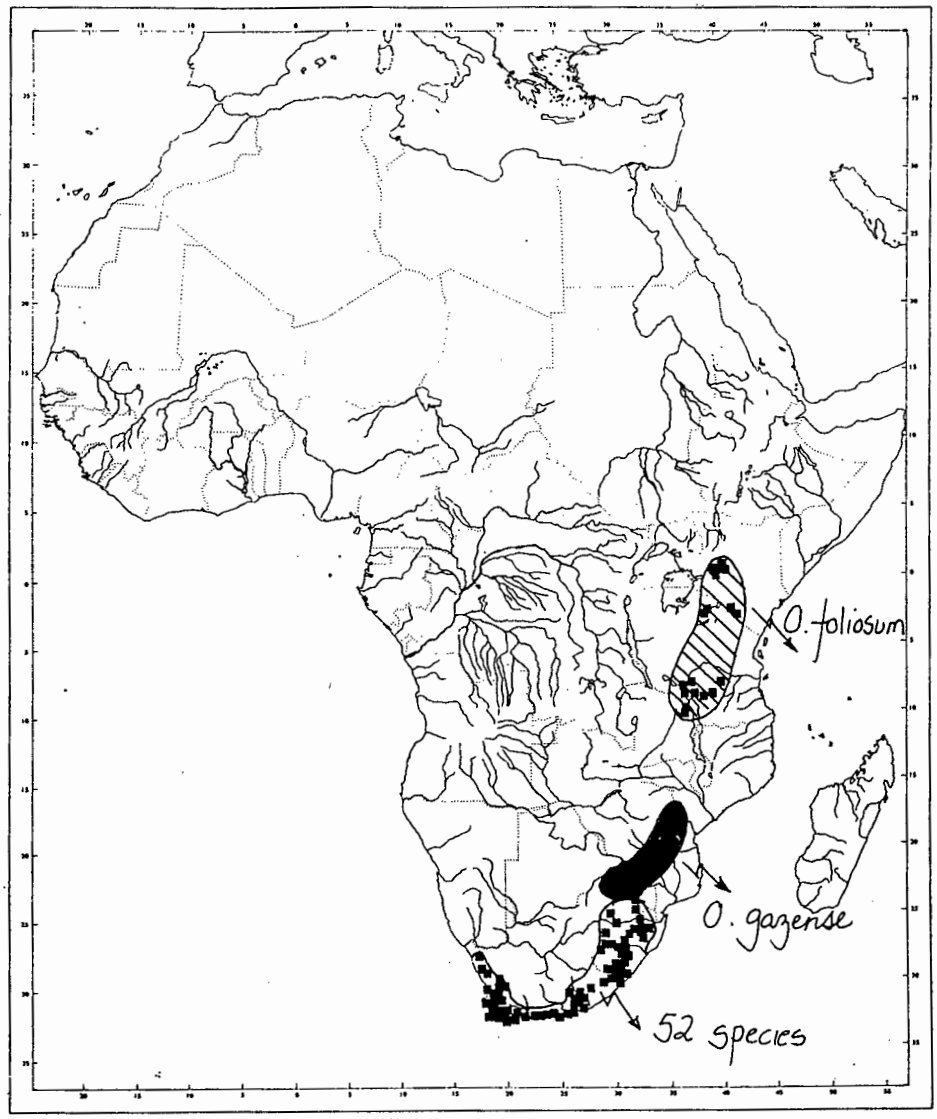


Fig. 5.1 Total distribution of *Otholobium* in Africa.

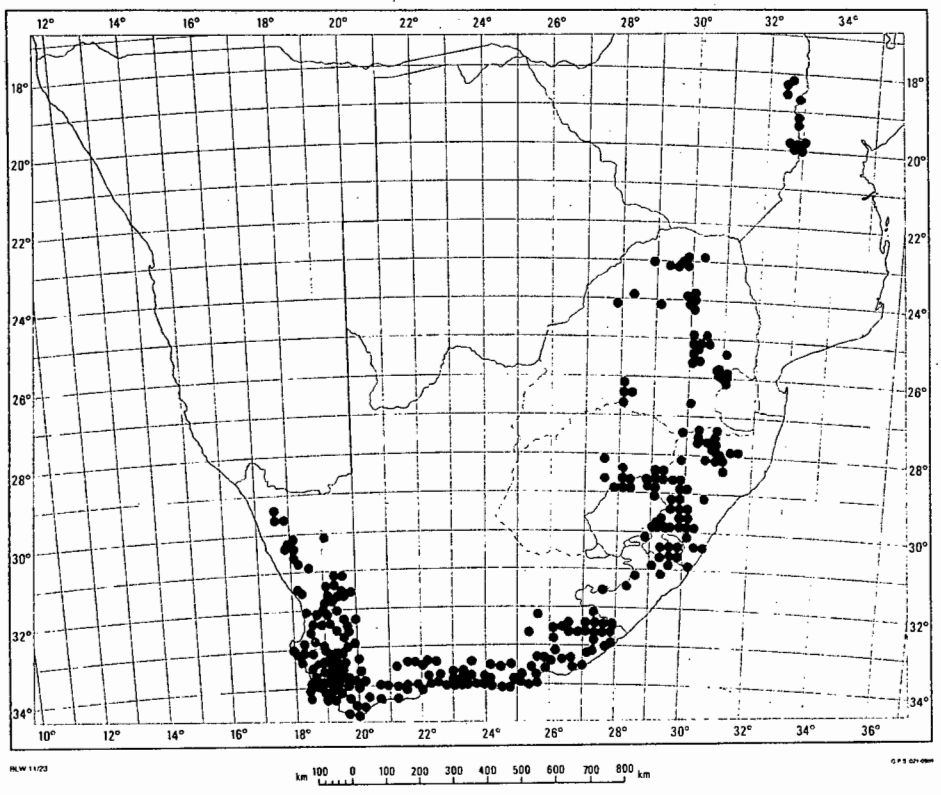


Fig. 5.2 Known distribution of *Otholobium* in southern Africa.

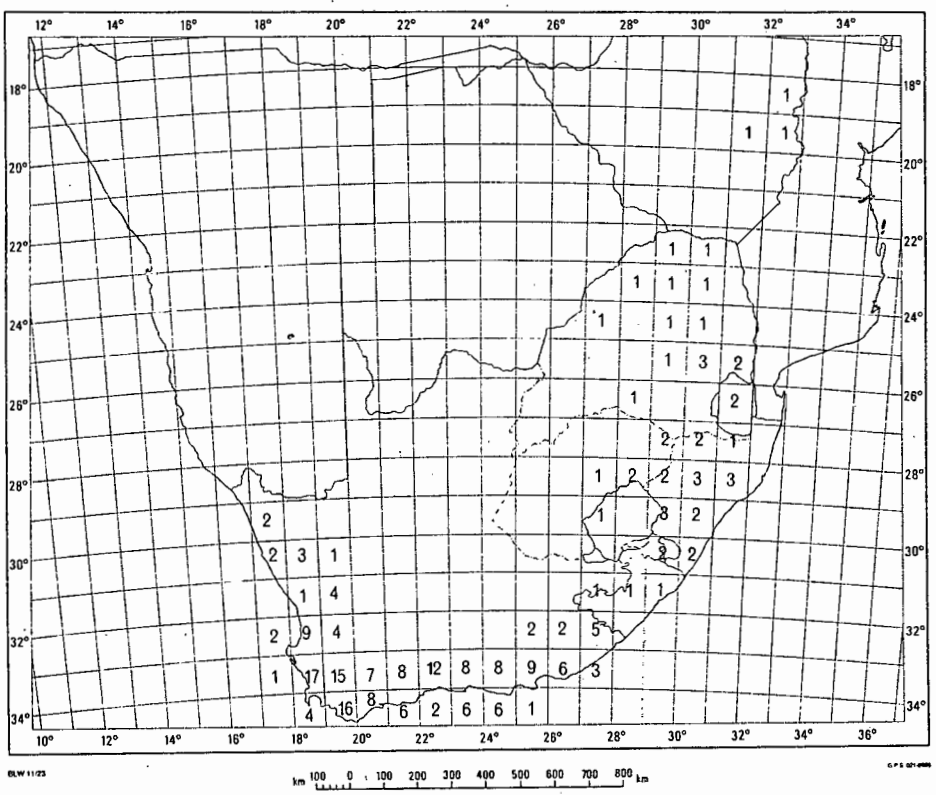


Fig. 5.3 Concentration map of *Otholobium* in the Flora of southern Africa region, based on the ranges of 52 species. The figures represent the number of species found within each one degree grid square. Note the high numbers of species in the Southwestern Cape Mountain districts (15-17) and in the Swartberg Mountains (12). The distributions of the two extra-South African species *O. foliosum* is not shown.

one species occurs north of this region (*Otholobium foliosum*; see the map of this species under the species accounts).

As pointed out by Dahlgren (1963, p. 437), Nordenstam (1969, p. 13) and Lundgren (1972, p.19) the sort of map shown in Fig. 5.3 is useful in providing a rough idea of the massing of some species and the scarcity of others. The highest concentrations of species are shown to occur in the one degree squares 3318, 3319, 3419 and 3322. There is generally a fall off in species as one moves eastwards and northwards from grid 3318DD. However, Figs. 5.2 and 5.3 are somewhat deceptive as they obscure some distinct localized concentrations of species particularly west of Robertson; eastwards to Humansdorp and Grahamstown. In Fig. 5.2, for example, each dot occupies a large area. These effects are less apparent in Figs. 5.4 and 5.5. In Fig. 5.4, plotted with greater resolution than Fig. 5.3, the species concentrations are more apparent, whereas in Fig. 5.5 the smaller areas of species concentration are more distinct. The areas of highest species concentration correspond to the Peninsular, South-Western, Southern and Northern Phytogeographical Centres of Oliver, Linder and Rourke (1983).

The centre of species richness in *Otholobium* is grid 3318DD centred on the Franschhoek and Stellenbosch areas and not centred, as is so common in typical Cape genera such as *Aspalathus* (Dahlgren, 1963), on grid 3418BB (Sir Lowry's Pass and the Hottentots Holland Mountains). The general pattern of species richness in *Otholobium* is one of a node with decreasing species numbers away to north and east from it and has been found in a wide range of Cape taxa (Oliver, Linder & Rourke, 1983): Restionaceae, Ericaceae, Proteaceae, Bruniaceae, Penaeaceae, Diosmeae (Rutaceae), *Aspalathus* (Leguminosae) and *Muraltia* (Polygalaceae). The species gradient from the Hottentots Holland Mountains northwards towards the Cedarberg is not as strongly marked as from Franschhoek towards Table Mountain. There is however a "hopscotch" gradient as one goes eastwards. This is evident from quite a number of maps of the taxa

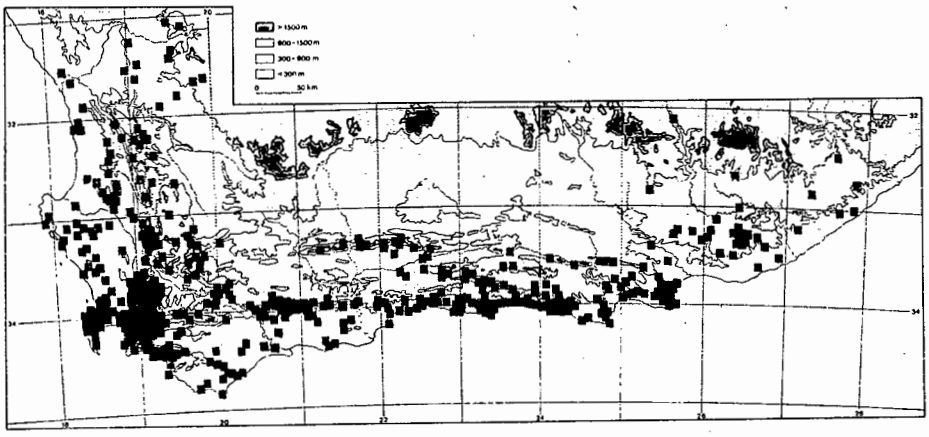


Fig. 5.4 Known distribution of *Otholobium* in Capensis sensu Taylor (1978a).

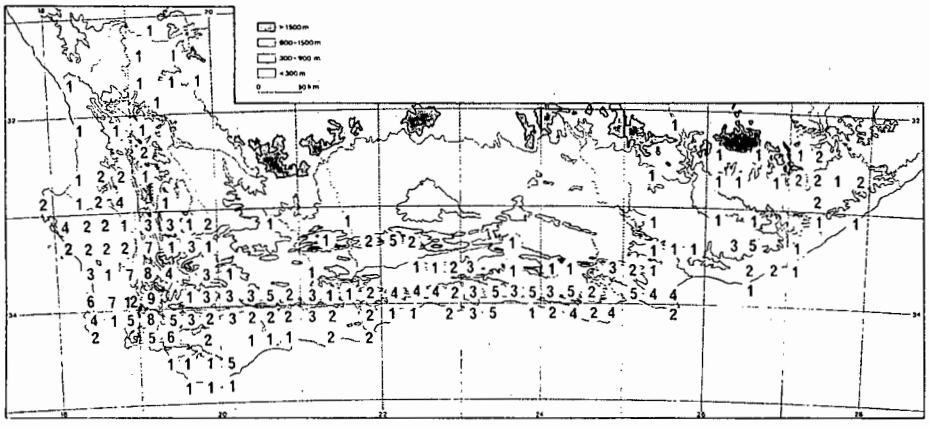


Fig. 5.5 Concentration map of *Otholobium* species in Capensis sensu Taylor (1978a). Each member represents the total number of species per one sixteenth degree square.

analysed by Oliver *et. al.* (1983); although not noted by them. Their maps show localized high species concentrations in grids 3320CD, 3321CC, 3322CD, 3323CC, 3324CD and 3325CC. Some of this may be due to poor collecting in the intervening areas, but is probably also partly due to the island nature of the mountains in the region. *Otholobium* exhibits a similar pattern with higher species concentrations in many of the above grids but with less marked number fluctuations along the gradient, species turnover being high as one proceeds eastwards. This phenomenon needs careful evaluation.

5.4. **Phytogeographical groups**

The following analysis of the distribution patterns of *Otholobium* will be covered under three main headings: species, endemism and patterns of speciation.

In surveying a medium-sized genus like *Otholobium* one has the opportunity of mapping many species then comparing the distributions to see if there are any patterns within the genus as a whole. Naturally if enough genera are analysed one is able to eventually discern distribution patterns which might give one an insight into the origins of the floras themselves.

Probably the most important and influential analysis of distribution patterns of South African plants was the book *Phytogeographical Groups, Centres and Intervals within the Cape Flora* by Weimarck (1941). Many authors have used his groups, centres and intervals (Fig. 5.6) in analysing their own work (Dahlgren, 1963, 1968; Nordenstam, 1969; Oliver, Linder & Rourke, 1983). For the purposes of this study I have used Dahlgren's revised classification of Weimarck (1941); partly because *Aspalathus* is a typical endemic Cape Legume genus and partly because no suitable alternative scheme is available. The recent more simplistic scheme of Oliver, Linder and Rourke (1983) is based essentially on the same premises as those adopted by Weimarck (1941). It is not surprising there-

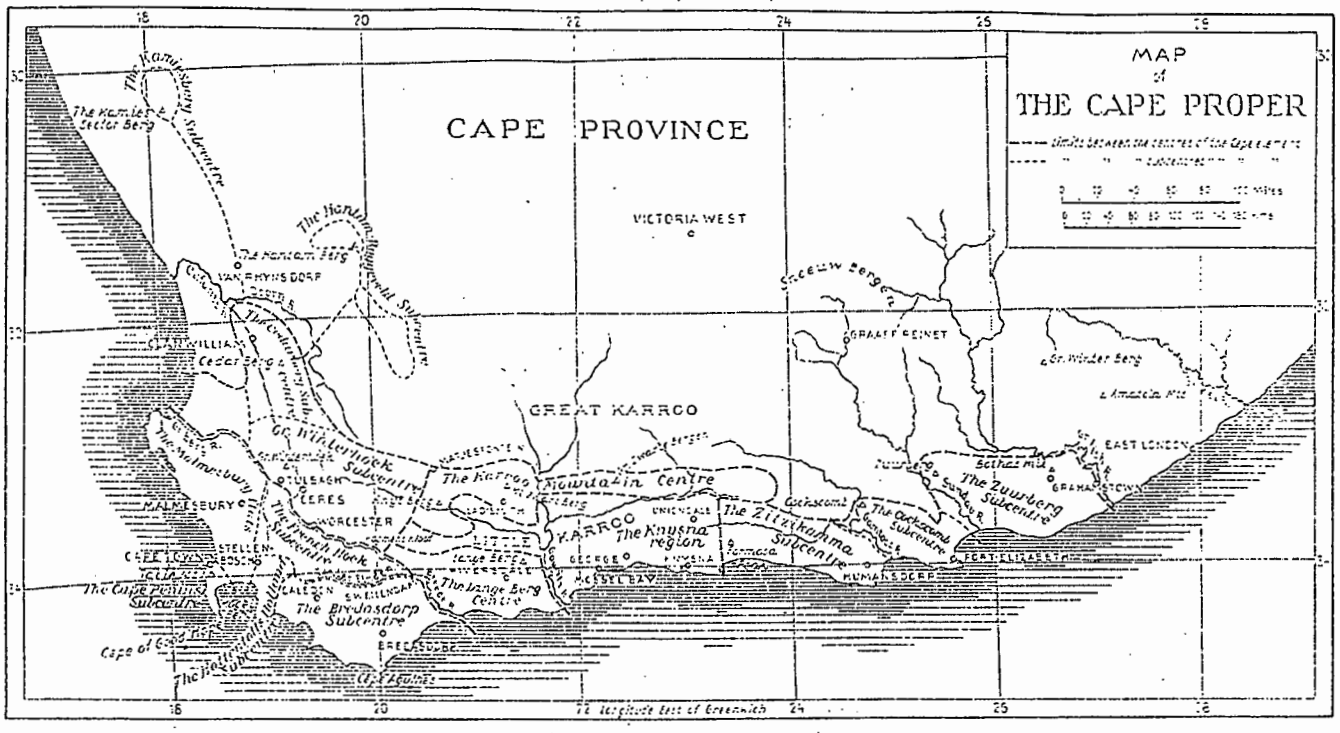


Fig. 5.6 Phytogeographic Centres and Subcentres of Weimarck's (1941) Cape Element.

fore that they should have arrived at more or less the same conclusions. I shall be using Dahlgren's modified classification of Weimarck's centres but will, for comparison's sake, indicate Oliver *et al.* 's (1983) terminology, in parentheses, where suitable. I have also used Nordenstam's (1969) centres and subcentres for taxa which are distributed beyond Capensis.

5.4.1 **Cape species**

Cape species are those which are mainly or entirely limited to the Cape proper (Weimarck, 1941, p. 8).

5.4.1.1. **The Cape Ubiquists** (Fig. 5.7)

This group comprises species which have a wide distribution in the Cape.

Strictly speaking there are no real ubiquists in Weimarck's sense. *Otholobium virgatum* has the most widespread distribution of any *Otholobium* in the Cape. It is a very variable species with various clines of hairiness and leaf shape from west to east. It occurs in all centres except the Karoo Mountain centre. Two other widespread species, which are absent from any one centre are: *O. candicans,* which occupies all of Weimarck's centres but which is clearly absent from Oliver *et al.*'s (1983) West Coastal, Peninsula and Bredasdorp centres; and *O. bracteolatum*, which is absent from the Northwestern centre (Northern). As for *O. virgatum* these species exhibit a number of localized variants and show various clines in pubescence, flower colour and leaf size.

There are no Cape ubiquists with a Knysna interval.

5.4.1.2. **The Western Group** (Fig. 5.8)

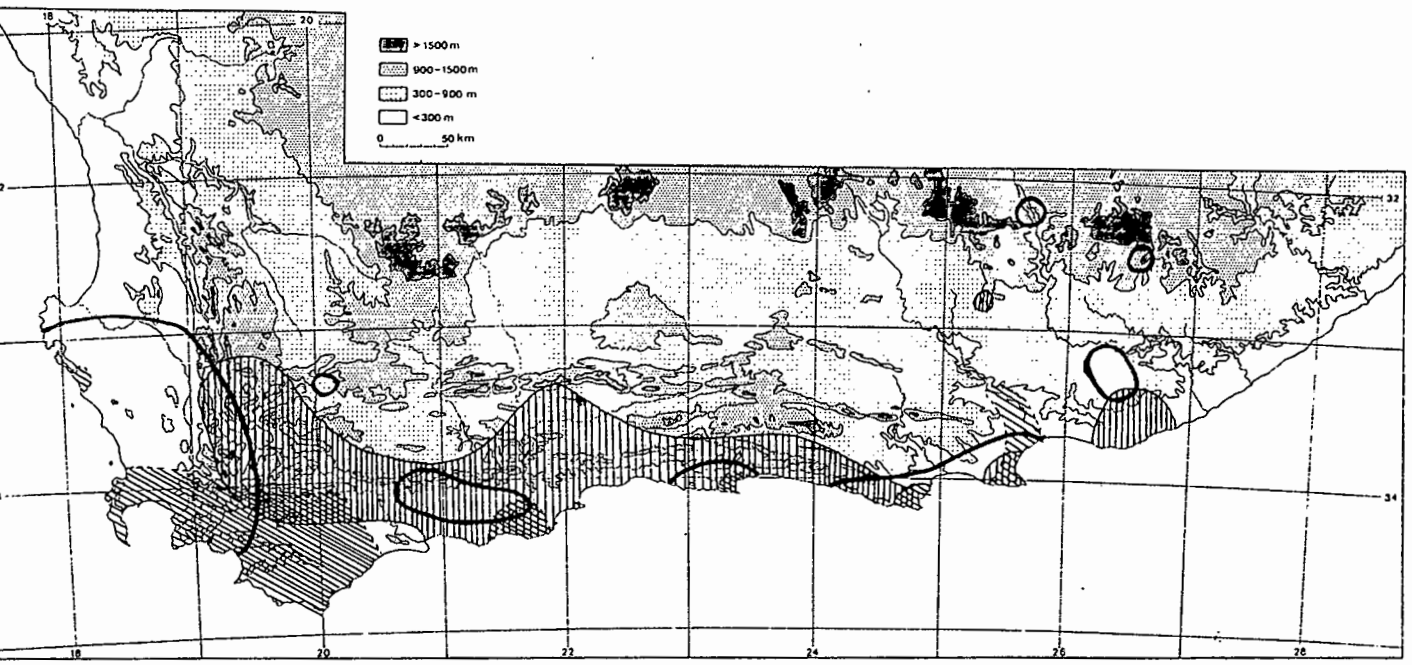


Fig. 5.7 The Cape Ubiquists.

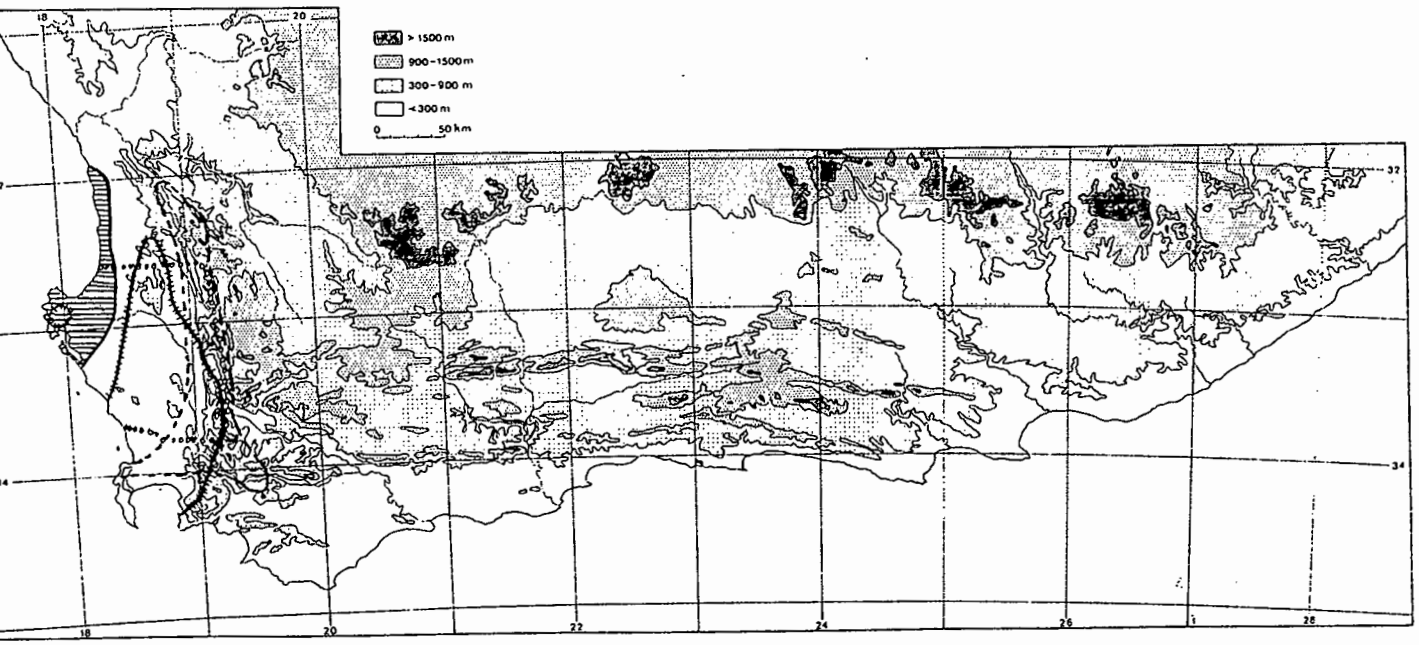


Fig. 5.8 The Western group.

This group includes species occurring in both the Northwestern and Southwestern centres (Northern, Western, South-Western, Bredasdorp and Peninsula centres). These species are either sharply restricted to the lowlands or to the western mountain ranges. Especially typical of the western lowlands are *O. hirtum* and *O. bolusii* whereas *O. trianthum* and *O. venustum* are to be found at the foothills of mountains or on small isolated rounded hills. The latter two species do not occur in the western lowlands. *O. uncinatum* is also a foothill plant but extends further south than the other species.

5.4.1.3 **The Karoo Mountain - Western Group**

This group refers to species which occur in the Karoo Mountain centre and in one or more of the western centres. There are no species of *Otholobium* with this distribution pattern.

5.4.1.4 **The Southern Group** (Fig. 5.9)

The species of the Southern group differ from the Cape Ubiquists in that they are absent from the area north of the Breede River and Great Berg River valleys. Essentially they are coastal species and range from the Southwestern centre to the Southeastern centre. Three species of *Otholobium* have this distribution. *O. prodiens*, a mountainous species, and *O. sericeum*, a coastal lowland species, both extend from the Bathurst District in the east to the Breede River in the west. *O. stachyerum* only extends westwards as far as George.

5.4.1.5 **The Southern Species with a Knysna Interval Group**

This group differs from the Southern Group in that the species are absent from the Knysna region but occur on either side of it. There are no species of *Otholobium*

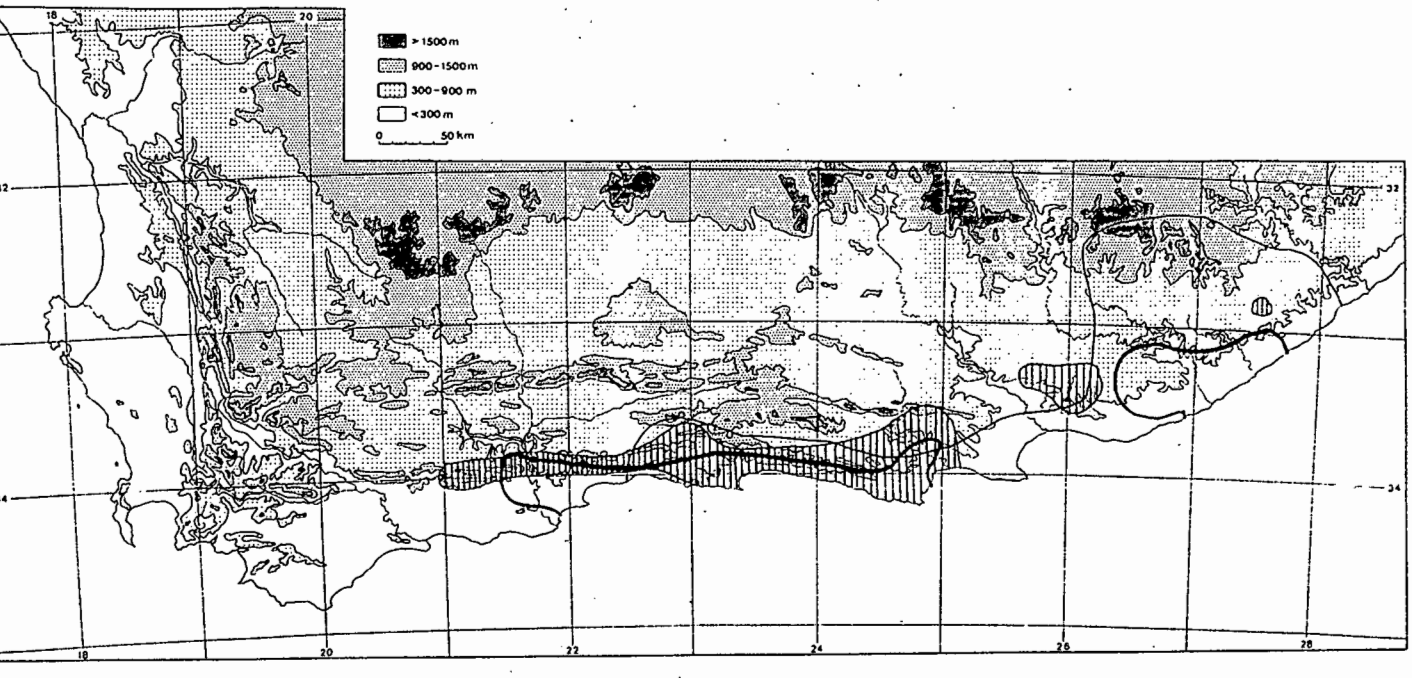


Fig. 5.9 The Southern group.

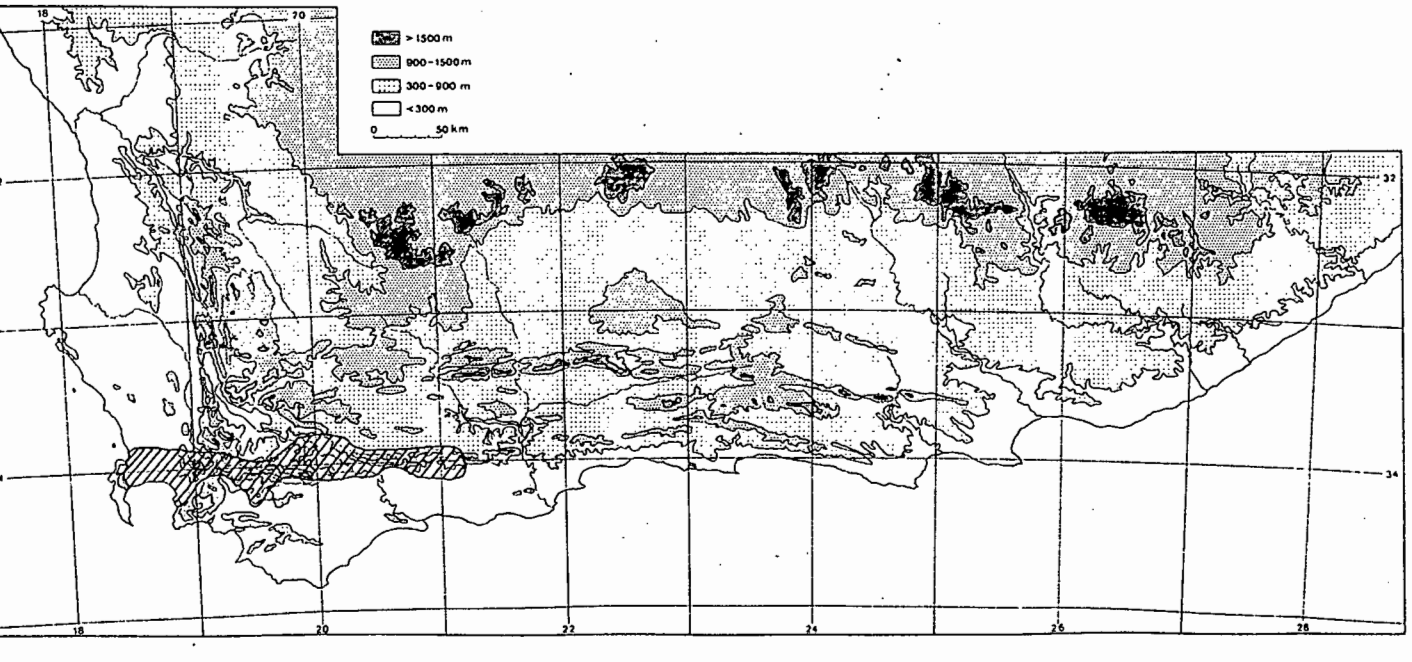


Fig. 5.10 The Langeberg - Southwestern group.

with this distribution pattern but it does occur in one species of *Psoralea*; *P. repens*, a stoloniferous colonizer of coastal sand dunes.

5.4.1.6. **The Langeberg - Southwestern Group** (Fig. 5.10)

In this group the species are represented in both the Southwestern and the Langeberg centres. The only species with this distribution is *O. spicatum*; a free-seeding, fire-susceptible pioneer species.

5.4.1.7. **The Southwestern Endemics** (Figs. 5.11 & 5.12)

The species in this group are restricted to the Southwestern centre; with the Breede and Great Berg Rivers being the absolute limits. This subregion constitutes one of the most important centres of endemism in the Cape element (Weimarck, 1941, p. 35; 149/462 species he surveyed). Most of the species are localized, only rarely occurring throughout the area. He recognizes 4 subcentres: **Cape Peninsula, Franschhoek, Hottentots-Holland** and **Bredasdorp** subcentres.

Otholobium occurs in all of Weimarck's subcentres.

O. sabulosum and *O. pungens* are endemics of the Bredasdorp subcentre. The distribution of *O. pungens* is very interesting as it occupies the two extreme ends of the subcentre. Both species are predominantly calciphilous.

There is only one species of *Otholobium* that is endemic to the Cape Peninsula subcentre, the mountain species *O. fruticans*.

Otholobium parviflorum, *O. nitens*, and *O. obliquum* traverse both the

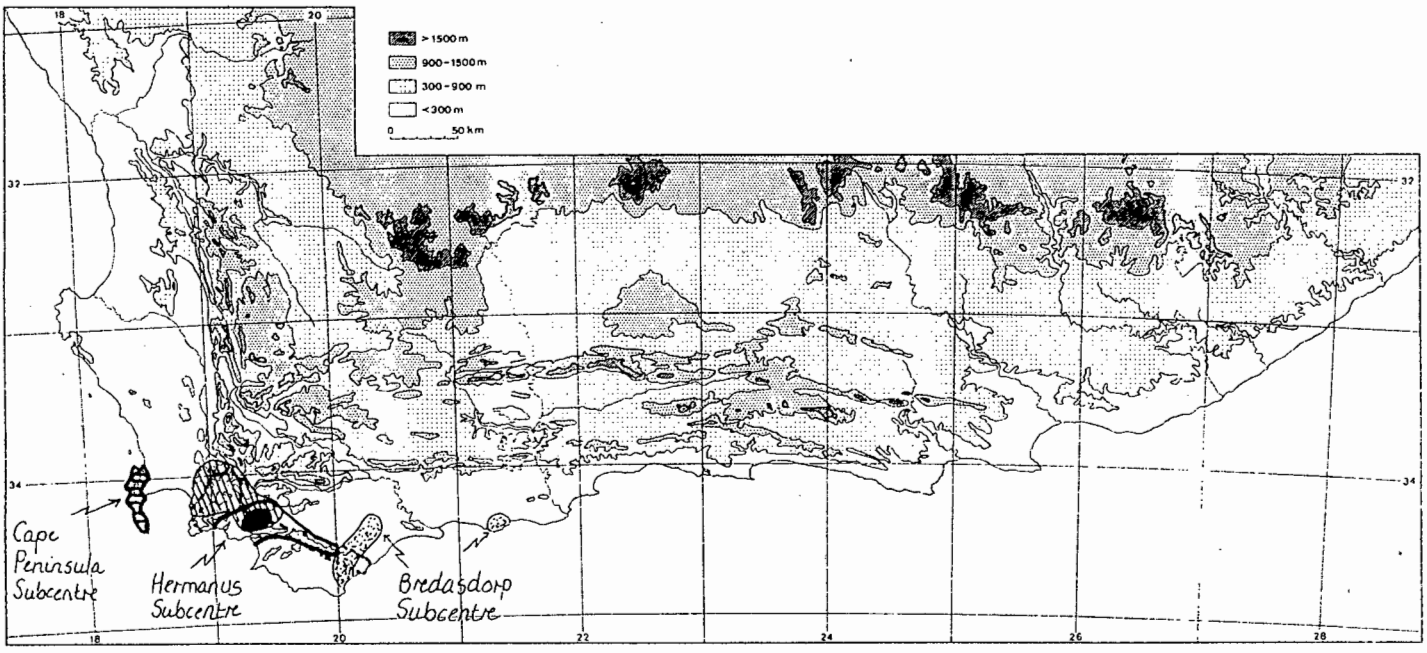


Fig. 5.11 The Southwestern Endemics - Cape Peninsula, Hermanus and Bredasdorp subcentres.

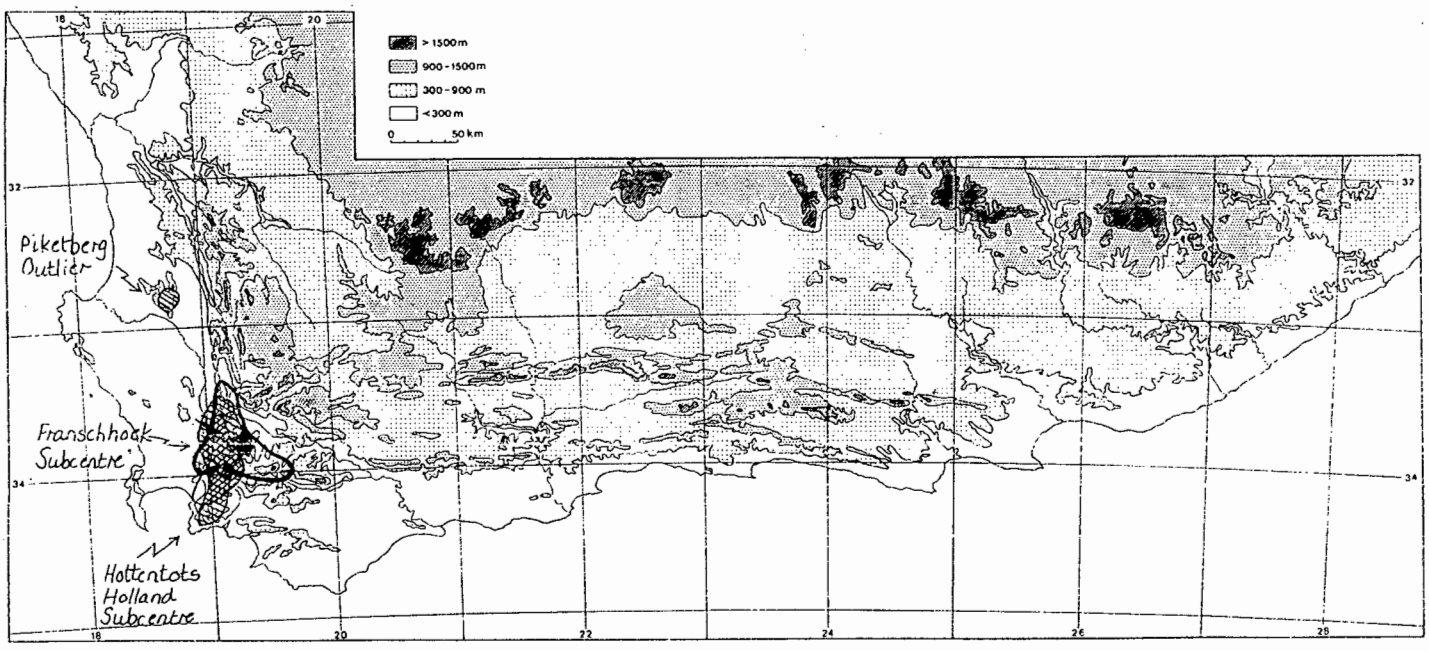


Fig. 5.12 The Southwestern Endemics - Franschhoek and Hottentots Holland subcentres. Note the Piquetberg outlier.

Franschhoek and the Hottentots-Holland subcentres; with *O. obliquum* having a disjunct outlier in the Piquetberg Mountains. *O. mundianum* is the only endemic of the Franschhoek subcentre.

There are five species which do not conform to any of the Weimarck's subcentres. They are centred on the Kleinriviers Mountains near Hermanus. This is, I believe, a distinct subcentre which I refer to here as the Hermanus subcentre. The five species are: *O. dreweae, O. lanceolatum, O. rotundifolium, O. thomii* and *O. zeyheri.*

5.4.1.8. **The Northwestern Endemics** (Fig. 5.13)

The Northwestern centre extends from north of the Breede and Hex River valleys and west of a line from Kogmans Kloof near Montagu and Karoopoort near Matjesfontein. Generally the Olifants River and the Doorn River fix the northern and northeastern limits respectively. Weimarck (1941) treats the Kamiesberg and the Hantam-Roggeveld Mountains as fynbos outliers of this centre.

This centre consists of lowlands in the west and mountains in the interior and has four subcentres: The Great Winterhoek, Cedarberg, Kamiesberg and Hantam - Roggeveld subcentres. However, there appears to be little agreement on the relative importance of these subcentres and of how distribution patterns north of the Southwestern centre should be treated, each author treating them differently. Dahlgren (1963), for example, treats this centre cursorily, as apart from *Aspalathus pulicifolia* recorded from the Kamiesberg subcentre in the north, most of the endemic *Aspalathus* species found in the centre are very local endemics from the southern part of the centre. Nordenstam (1969), by contrast, pays particular attention to this

region and areas to the north of it. This is because *Euryops* extends well beyond Capen-

sis. Oliver *et.al.* (1983) merely confirm that their Northern centre is identical to Weimarck's Northwestern centre; paying no attention in the process to the fynbos outliers to the north of the Oliphants River.

Three *Otholobium* species are endemic to the Northwestern centre in its restrictive sense. They include *O. spissum*, *O. incanum* and *O. venustum*. Two of these represent undescribed species. The other species, which occur in this region, but to the north of the Oliphants River, are found in Weimarck's subcentres. The species included are: *O. arborescens*, *O. argenteum*, *O. flexuosum*, *O. hamatum* and *O. pustulatum*.

O. arborescens has a wide distribution which is very similar to *Euryops multifidus* and *E. tenuissimus* (Maps 82 & 83, p.47, Nordenstam, 1969); two species which Nordenstam referred to as belonging to a Namaqualand - Cape group. *O. arborescens* extends from Namaqualand into the Cape region and is found in Mountain Renosterveld.

The distribution of the local endemic *O. pustulatum* matches that of *Euryops pleiodontus* (Map 86, p. 47, Nordenstam, 1969) and falls within his Namaqua Group.

O. hamatum falls within Weimarck's Kamiesberg subcentre. *O. flexuosum* and *O. argenteum* are endemics of the Hantam-Roggeveld subcentre.

5.4.1.9. **The Langeberg Endemics** (Fig. 5.14)

These endemics are restricted to the Langeberg centre. There are only two species of *Otholobium* which are endemic to the Langeberg centre: *O. bowieanum* and *O. saxosum*. Both form large colonies wherever they occur.

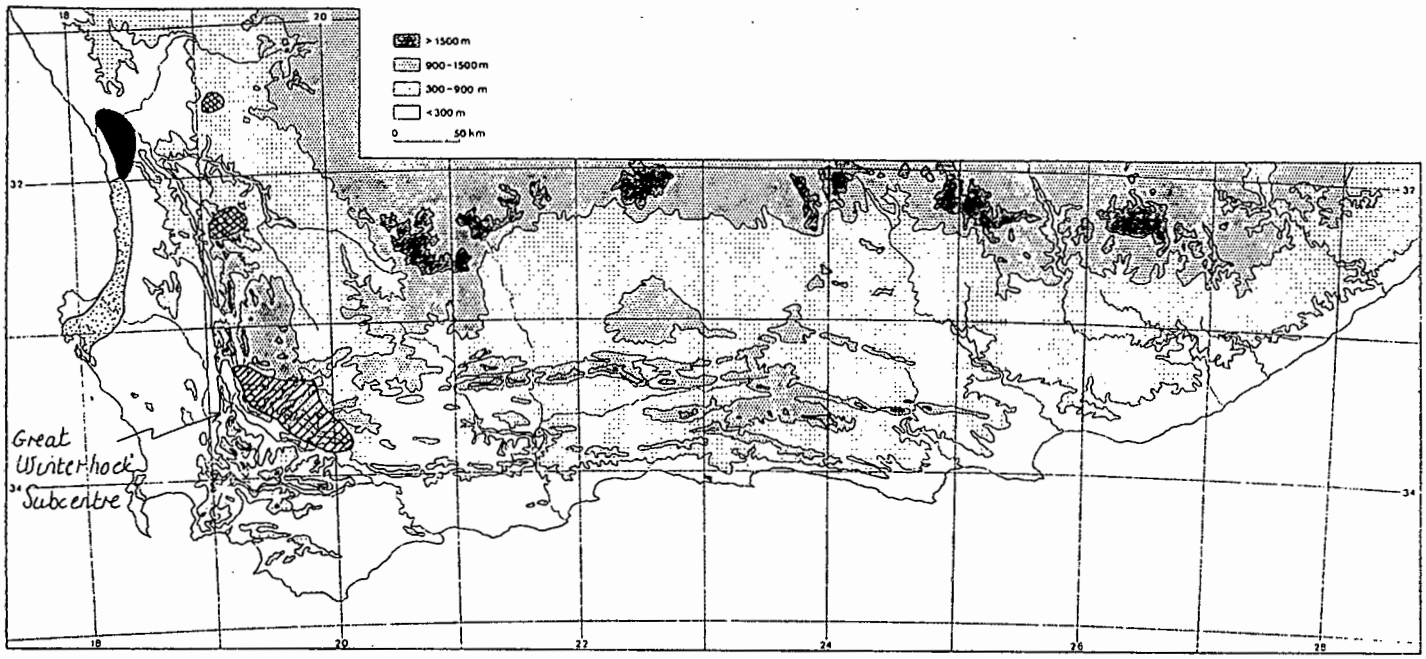


Fig. 5.13 The Northwestern Endemics showing the Great Winterhoek subcentre.

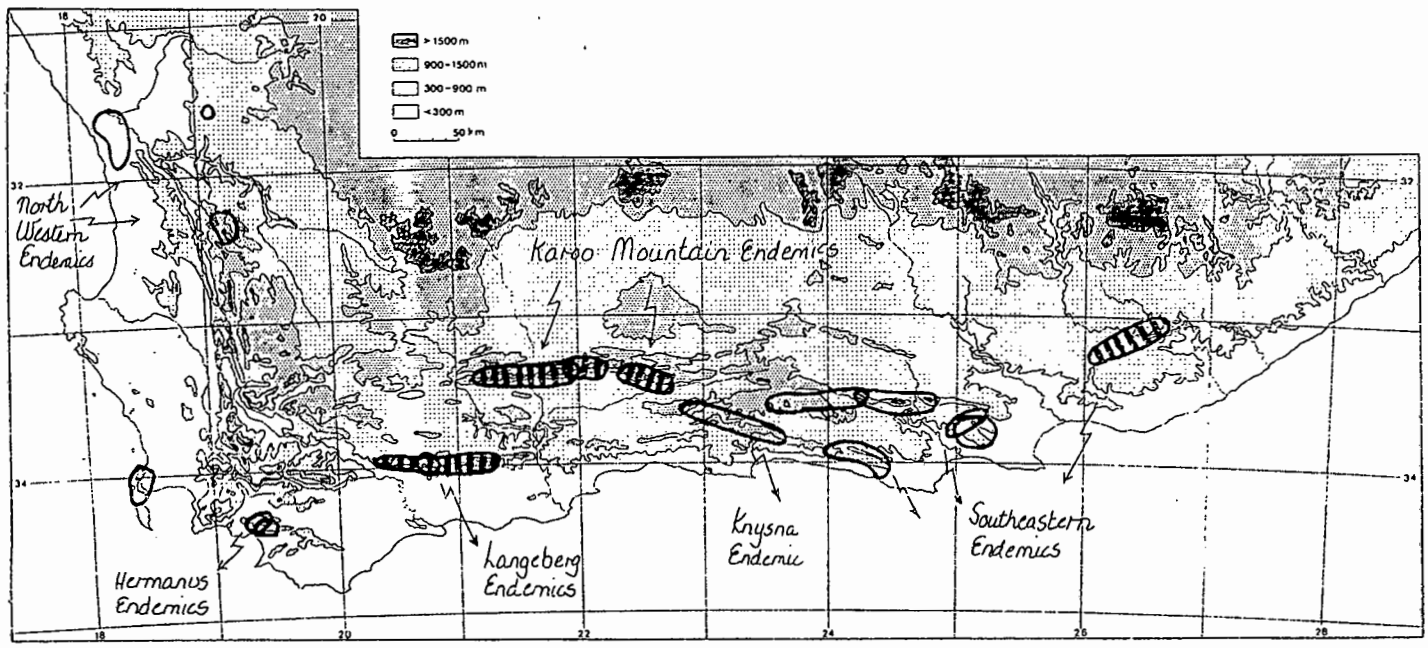


Fig. 5.14 The Langeberg and Karoo Mountain endemics. Also shown are the areas of endemism of *Otholobium* across the Cape.

5.4.1.10 **The Karoo Mountain Endemics** (Fig. 5.14)

The group includes species endemic to the mountains within the Karoo Mountain Centre, viz. the Witteberg, Klein and Groot Swartberg mountains and their neighbouring mountains. The main centre is the Groot Swartberg Mountains. The taxa may be distributed on either side of the Gouritz River and because of the nature of the topography may occur on the upper usually southern slopes of the mountain peaks.

Four endemics, three of which are new species, are found in this region: *O. lucens*, *O. macradenium*, *O. rubicundum* and *O. swartbergense*. Apart from *O. rubicundum* which occurs in the lower foothills of the Klein Swartberg all the other species occur at higher elevations. A single outlier of *O. macradenium* is known from the Langeberg.

5.4.1.11 **Knysna endemics** (Fig. 5.14)

Only one species is more or less restricted to mountains in the Knysna centre; *O. racemosum.* This is in marked contrast when compared to *Psoralea* in which there are at least five endemics in the Knysna centre.

5.4.1.12. **The Southeastern Endemics** (Fig. 5.14)

This group comprises species limited to the Southwestern centre. Weimarck (1941) defined his Southeastern centre as comprising a narrow coastal strip from about the border between the Humansdorp and Knysna districts to the mountains in the Albany and Alexandria districts. Within this region he defines a number of distinct subcentres: Zitzikamma, Cockscomb and Zuurberg subcentres.

Both Nordenstam (1969) and Dahlgren (1963) divided Weimarck's centre into a Knysna centre and a Southeastern centre, the latter defined as east of Plettenberg Bay. However, Nordenstam did not refer to the Knysna centre as such, merely leaving it blank (Map 5, p. 19, 1969). Oliver, Linder, and Rourke (1983) on the other hand extended Weimarck's centre to as far west as the Langeberg and as far north as the Karoo Mountain Centre, calling it the Southern centre. This is too drastic as it obscures very important distribution patterns, particularly between the inner drier mountains and the wetter coastal mountains and plains.

There are seven species of *Otholobium* in this region, which represents the highest number of species of the genus found than anywhere else in the country.

Three species occur in the Zitzikamma subcentre: *O. heterosepalum*, *O. racemosum* and *O. acuminatum*. They occur predominantly on the Langekloof, Kareedouw, Zitzikamma and Kouga mountains.

Four species are centred on the Cockscomb subcentre: *O. accrescens* and *O. polyphyllum* are found on the Elands River and Van Stadens mountains, whereas *O. carneum* and *O. pictum* are found further inland on the higher Baviaanskloof and Winterhoek mountains.

O. piliferum has a unique distribution in *Otholobium*. It occurs towards the eastern extremity of the area occupied by the Southeastern endemics and comprises two rather disjunct populations.

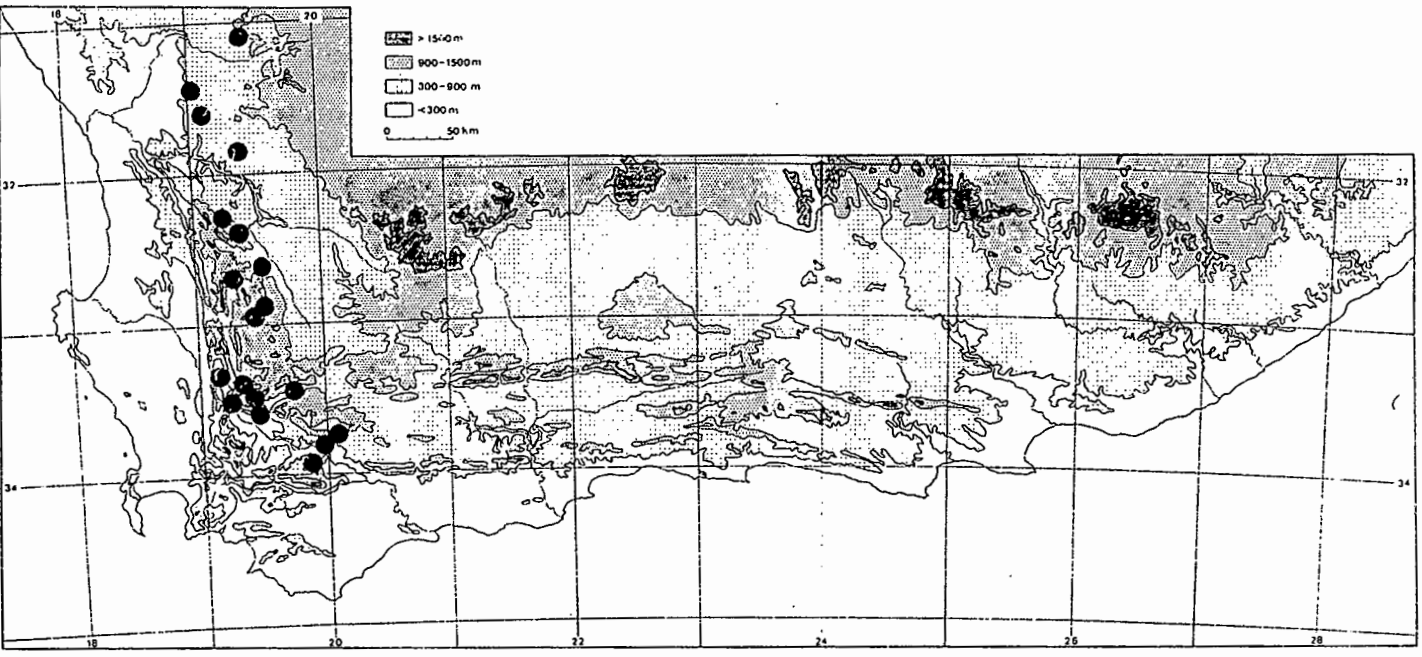


Fig. 5.15 The Namaqualand - Cape Group.

5.4.1.13 **The Namaqualand - Cape Group** (Fig. 5.15)

The species of this group have a northwestern distribution in Namaqualand and extend into the Cape region. A typical species with such a distribution is *O. striatum*. It grows mainly in succulent Karoo or arid fynbos areas.

5.4.2 **Species occurring outside the Cape proper (cf. Weimarck 1941, p. 50)**

Weimarck (1941) recognized three centres outside the Cape proper: The Drakensberg centre, the Tropical African Mountain centre and the Madagascar centre.

Unfortunately there has been very little phytogeographical work done in southern Africa which has considered species extending beyond the Capensis region. Partly this has been due to the scarcity of monographs done on eastern species and partly due to the dominance Capensis oriented phytogeographers have had on the development of the subject in South Africa. The few studies that have been done have been too superficial to be helpful; for example, Hilliard (1978) in her paper on the geographical distribution of Compositae native to Natal lists 12 types of distribution patterns but does not relate them to the patterns indicated by previous workers. For these reasons I will use some of the working "centres" proposed by Nordenstam (1969) for extra-Cape species.

5.4.2.1 **The Drakensberg Endemics** (Nordenstam, 1969) (Fig. 5.16)

The Drakensberg Endemics comprise montane and alpine species restricted to the Drakensberg centre. Only one species of *Otholobium* belongs here. *O. fumeum* has a distribution identical to that of *Euryops montanus* (Nordenstam, 1969, p. 41).

5.4.2.2 **The Highveld Group** (Nordenstam, 1969) (Fig. 5.17)

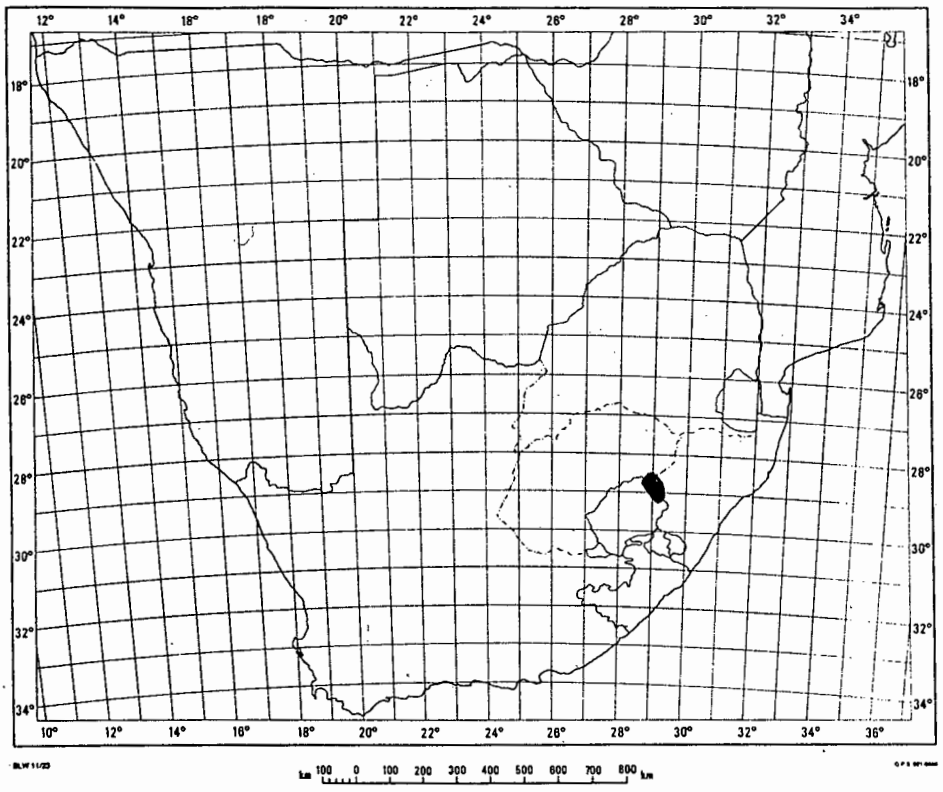


Fig. 5.16 The Drakensberg Endemics.

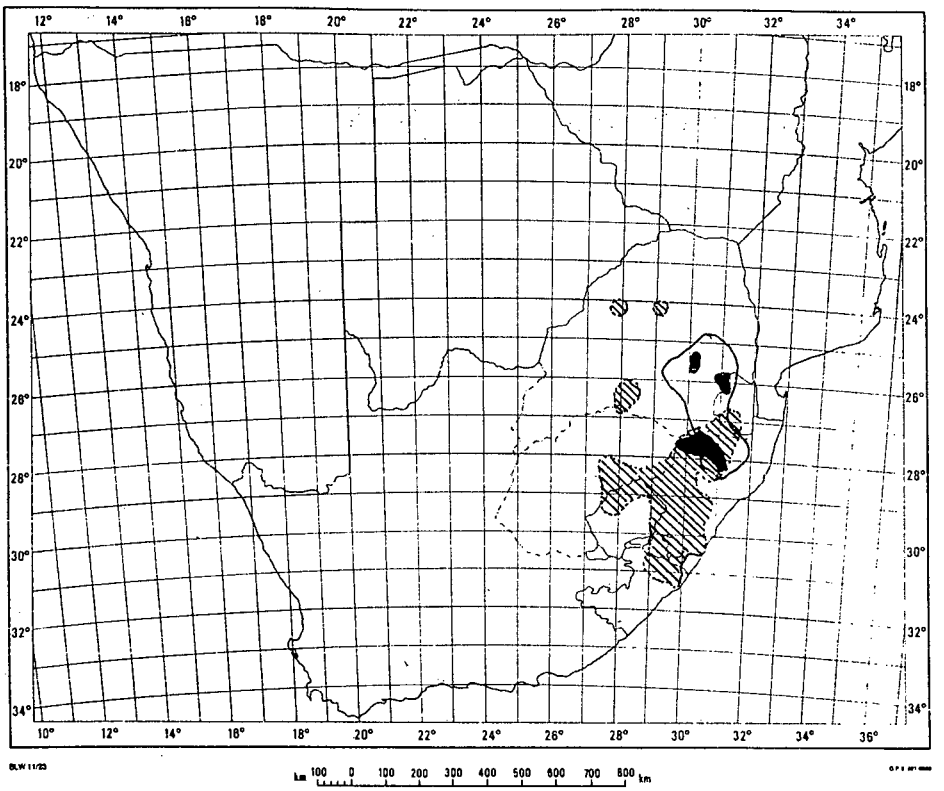


Fig. 5.17 The Highveld group.

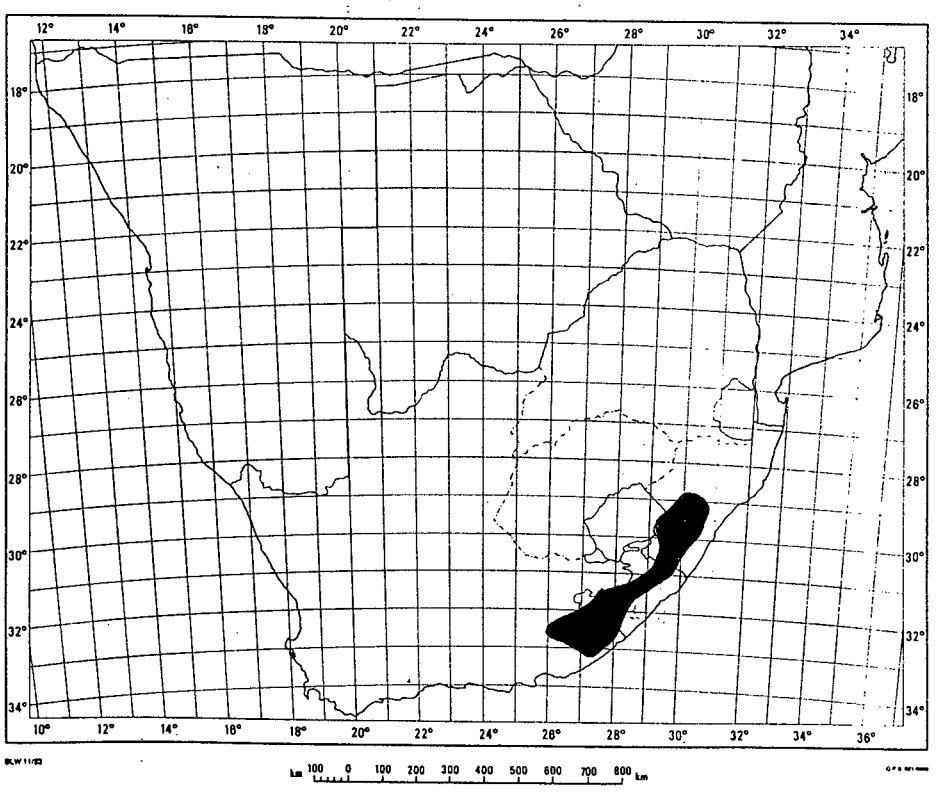


Fig. 5.18 The Kaffrarian-Transkei group.

The typical members of this group are to be found on the Transvaal Highveld, with many species extending into Swaziland and northern Natal. *Otholobium wilmsii*, *O. nigricans* and *O. polystictum* belong here.

5.4.2.3 **The Kaffraria-Transkei Group** (Nordenstam, 1969) (Fig. 5.18)

According to Nordenstam (1969) the members of this group occur in the southeastern coastal areas, from the southeastern Centre to southern Natal, often with extensions further west in the Cape region and further north into the Highveld.

Otholobium caffrum extends from the Katberg mountains in the south through the Transkei to as far north as The Dargle in Natal. It occurs commonly along forest margins or on rocky outcrops in grassland.

5.4.2.4 **The Tropical African Mountain Centre** (Nordenstam, 1969) (Fig. 5.19)

Only two species of *Otholobium* extend beyond the borders of South Africa. *O. gazense* occurs on the northernmost parts of the Drakensberg and in the Inyangani subcentre. *O. foliosum* occurs in both the Mlanje and Kenya subcentres; a distribution very similar to *Aristea alata* Bak. (Weimarck, 1940). The genus is absent from the Weimarck's Kivu, Abyssinian, Angolan, Cameroon, Katanga and Rungwe subcentres.

5.5 The phytogeographical centres of southern Africa

In his study of the phytogeography of *Euryops* Nordenstam (1969) proposed 9 phytogeographical centres or areas of significant foci of species concentration or endemism. *Otholobium* is present in his Caledon, Albany, Little Karoo, Van Rhynsdorp, Drakensberg, and Barberton centres.

There is still not enough published data to be able to test the validity of many of these centres. However, until a detailed phytogeographical analysis has been done for the whole country, they at least provide some guidelines for monographers. A welcome attempt is Anderberg's (1986) cladistic and phytogeographic analysis of *Pegolettia* (Compositae) in which he proposed a sequence of hypotheses to account for the distribution patterns.

5.6 **Endemism in** *Otholobium*

Endemic plant taxa have had a marked fascination for plant geographers since the beginning of the last century. This interest is probably attributable to their usual rarity and to their narrow and distinctive distribution patterns (Stott, 1981).

The concept of endemism is as wide or as narrow as the interests of the scientists who use it and may range from the distribution of *Acacia karoo* (endemic to Africa) to *Otholobium lanceolatum* (endemic to two hectares behind Shaw Mountain). To resolve this discrepancy phytogeographers have distinguished between **broad** and **narrow (local)** endemics. Brenan (1978) is an example of the study of endemism at the country or regional level. Here I will use local endemics in the same sense Dahlgren (1963) referred to them as species which occupy a few restricted localities or a group of isolated mountain tops.

Plant endemics have been classified in a number of different ways (Engler, 1882; Prentice, 1976; Richardson, 1978; Stebbins & Major, 1965). As Stott (1981) points out most of these classifications have distinguished broadly between plants which arise by differential evolution in a particular area from which they have not spread or are unlikely to spread (**autochthonous, progressive, secondary endemics, neoendemics**) or taxa which once possessed a wider distribution but which are now occupying a limited

portion of their former territory (**Conservative, relict endemics, epibiotics, palaeoendemics**).

Various criteria have been suggested which could be used to distinguish the different types of endemics, but in general these are very difficult to apply (Dahlgren, pp. 465-470, 1963, concerning *Aspalathus*). The system of Richardson (1978), which distinguishes between holoendemics, palaeoendemics and neoendemics, has proved most suitable for differentiating the endemicity of *Otholobium*. Richardson uses the following criteria (* used in present analysis): *taxonomic isolation, *geographical isolation, *polymorphism, derived characteristics, *environmental stability, ploidy level, age, and *potential to expand area. By using five of these criteria it has been possible to make tentative suggestions about the types of endemics which occur in *Otholobium*:

(i) **Palaeoendemics** - *accrescens*, *argenteum*, *dreweae*, *incanum*, *lanceolatum*, *nitens*, *pictum*, *pungens*, *rotundifolium*, *swartbergense*,, *thomii*, *zeyheri*.

(ii) **Neoendemics** - *bowieanum*, *lucens*, *piliferum*, *rubicundum*, *saxosum*.

Fig. 5.14 shows the broad distribution of these endemics. It would appear that the neoendemics do not occupy the same regions as the palaeoendemics. A similar finding was made by Adamson (1960) in his phytogeographical study of Molluginaceae.

The origins of these patterns are difficult to determine. As Linder (1985) points out there are two main approaches to the problem of speciation in southern African: the classical biosystematic approach or the ecological approach. I would agree with him that because Capensis (well-described in Taylor, 1978a) is so complicated physiographically that there must be "extraordinarily steep environmental gradients of water availability, optimal growth periods and soil conditions" and that consequently "ecological specia-

tion" centred on fire, hybridization and changing climate must account for many of the species. The fact that glaciation did not accompany the climatic changes of the Pleistocene at the Cape (Deacon, 1979) may well have been offset by the extensive fluctuations in temperature and rainfall which must have affected species distribution ranges. Linder (1985) has suggested that 30% of the species of the Cape Floristic region may be due to geographical displacement and the remainder to beta diversity, or replacement along ecological gradients. The distribution patterns of *Otholobium* together with the data presented in Chapter 8 would support such a hypothesis. However, Nordenstam (1969) has pointed out speciation in the Karooid areas north of Capensis, with their pockets of fynbos, could have evolved more by hybridization and polyploidy than by ecological speciation; much of the endemism in these areas being progressive (neoendemic).

5.7 **Conclusions**

1. *Otholobium* is distributed across a wide range of habitats, the most common being either arid fynbos or renosterbos, or eastern mountain grasslands. (Fig. 5.20).

2. 96% of the species of *Otholobium* occurs within the borders of southern Africa. The patterns of endemism in *Otholobium* are very different from those reported by Dahlgren (1963, p. 468) for *Aspalathus*.

3. 17 species are narrow endemics. There are no endemic species of *Otholobium* in the coastal areas of the Western, Southwestern, Langeberg, Knysna and Southeastern centres. The few that occur are always on mountains or hillsides away from the coast.

Fig. 5.20 Typical habitats of southern and eastern representatives of *Otholobium*. 1, Western Piquetberg Mountains; 2, Ngeli Mountain area in Natal.

4. The palaeoendemics have a different distribution pattern to the neoendemics.

5. Notwithstanding the number of species distributed northwards from its centre of species diversity and the high number of species dispersed across the many parallel fold mountains of the central Capensis area it would seem that *Otholobium* is an element of Capensis sensu Taylor (1978a). However, as Nordenstam (1969, p. 69-73) points out, using *Euryops* as an example, such an exercise may be academic.

CHAPTER 6

PHYTOCHEMISTRY

6.1 Introduction

In the last twenty years there has been an enormous interest in phytochemistry as an aid to plant systematics and classification (Kubitzki, 1984). Rodman (1981) has suggested that phytochemical characters have attracted attention for two fundamental and interdependent reasons:

(i) They produce new kinds of characters which can be used to test existing classifications which are largely based on comparative morphology and anatomy.

(ii) They give greater insight to the determination of homology and analogy, especially if biosynthetic pathways, enzymology, and genetic data are available.

Ideally a systematist should compare the whole array of chemicals in the taxa under revision. However, in practice systematists rarely look at more than one class of compounds. This may be due to the long time it may take to analyse diverse chemicals, to the many problems of a technical nature, the expense involved, to phytochemical complexity, and finally to the lack of information about biogenetic pathways which would allow one to sequence the data. One could also add a subconscious suspicion that adding different chemical data might actually alter the classifications produced (i.e. the

non-specificity hypothesis does not hold true; Sokal & Sneath, 1963). There are indeed some well-worked out examples where the morphological and chemical properties of populations are not correlated (Payne, 1976).

This study of the chemistry of the African Psoraleeae was undertaken for three reasons:

1. to determine whether chemical data would help resolve generic delimitations.

2. to test whether different classes of chemical compounds, from the same plant organ, would provide the same or different levels of taxonomic information.

3. to discover which class of chemicals would be most effective in analysing hybrid populations.

The results of this study, which was undertaken jointly with Marion Boardley and Jeffrey Harborne of the Plant Sciences Laboratory of Reading University, have been published in *Biochemical Systematics and Ecology* (Boardley, Stirton & Harborne, 1986; See Appendix 13, this thesis). In the next section I will update some of the names of the voucher specimens and will comment on a few papers which appeared subsequently and which add new data; the genus *Cullen* in particular.

6.2 **Results**

See published paper in Appendix 13.

6.3. Comments on published paper

(a) A number of the specific epithets of the voucher specimens are incorrectly spelled in the various tables. Unfortunately I was abroad when the page proofs were ready so was unable to correct these. These should read *O. bracteolatum*, *O. caffrum*, *O. spicatum*, *O. striatum*, *O. stachyerum*, *O. uncinatum*, *O. zeyheri*. *Stirton 8923* cited as *O.* sp. is *O. nigricans*. *Stirton 8237* cited as *O. brevibracteatum* is *O. bracteolatum*. *Stirton 9307* cited as *O. stachydis* is *O. hirtum*. *O. salignum* has been renamed *O. incanum*.

(b) Since this paper was published two reports on Psoraleeae have come to my attention (Innocenti, Cappelletti & Caporale, 1984; Cappelletti, Innocenti & Caporale, 1984). Both refer to the genus *Cullen*: *C. corylifolia*, *C. leucantha*, *C. lachnostachys*, *C. pustulata*, *O. martinii*, *O. plumosa* and *O. cinerea*. Two major furanocoumarins - psoralen and angelicin - were found in the seeds of these species and occurred both as glycosides and in the free state; the ratios of these chemicals were shown to be different in the different species. The species also contain bakuchiol. Angelicin and psoralen show skin-photosensitizing properties whereas bakuchiol exhibits antimicrobial and antiviral activities (Innocenti *et al.*, 1984).

In our paper we reported that leaf material of *Cullen obtusifolia* from southern Africa did not contain psoralen. This is interesting as all the Asian and Australasian species studied so far contain this compound in abundance in the seeds. The seeds of African Cullens need to be examined for psoralen. The high concentrations of furanocoumarins in seeds may be ecologically important for these essentially dryland plants as such compounds are known to act as growth and germination inhibitors (Bennet & Bonner, 1953) and could inhibit germination of seeds of competing species. The highest concentrations appear to be in the pericarp (Cappelletti *et al.*, 1984).

A range of naturally occurring isoflavonoids has been found in various Psoraleeae; that is, natural products containing the 1,2-diphenyl-propane ring system. 90% of the fully characterized isoflavonoids (aglycones + glycosides) of plant origin are known almost exclusively from the Leguminosae (Ingham, 1983). These compounds may be divided into **constitutive** (components of normal healthy tissue) or **induced** (mostly produced in response to microbial invasion).

The following isoflavones have been isolated in Psoraleeae: daidzein (roots), corylinal, corylin, coumestrol (roots), neobavaiso flavone, psoralenol, psoralidin, isop-soralidin, psoralidin oxide and corylidin in seeds of *Cullen corylifolia*; daidzein[3]-7-0-glucoside (root) and glyceollin 1 (leaf) in *Bituminaria acaulis*; glyceollin 1 in leaves of *Bituminaria bituminosa*; and glyceollin 1 in leaves of *Orbexilum onobrychis* (see Ingham 1983 and Darnley Gibbs, 1974, for references).

It is of phylogenetic interest that most complex 6aH-pterocarpans and all the known 6a-hydroxy analogues (both constitutive and induced) have been obtained only from the three tribes Phaseoleae, Desmodieae and Psoraleeae.

Glyceollin 1 has been shown to be toxic to isolated animal systems causing rapid haemolysis of red blood cells (Ingham, 1977). Coumestrol and daidzein are oestrogens and if ingested by livestock over longish periods result in infertility. These points are of economic interest as only some Cullens and Otholobiums are grazed preferentially by livestock.

(c) In our introduction we referred to the survey by Ockenden, Alston & Naifeh (1965) of flavonoid chemistry of 30 species of north American *Psoralea* (*Orbexilum* sensu lato).

Darnley Gibbs (1974) comments on this study as follows:

"According to Ockenden et al (1965) the high degree of morphological diversity in **Psoralea** *is not accompanied by equivalent flavonoid diversity. It is possible, of course, that* **Psoralea** *may be very diverse in some other aspects of its chemistry."*

Our study has shown that Darnley Gibbs's suspicions were correct and that *Psoralea* sensu lato has a wide array of taxonomically useful essential oils, flavones, proanthocyanidins and furanocoumarins. Current analyses with tannins and food preference studies add another level of diversity that is highly variable at the species level; different species in both *Otholobium* and *Psoralea* exhibiting a broad range of feeding response from insects ranging from unpalatability to complete palatbability (Simmonds, 1988). We are currently attempting to relate the different classes of chemical compounds to ecological, biological and environmental parameters.

(d) Unpublished studies on the flavonoid chemistry of six collections of *Bituminaria bituminosa* from Tenerife, Lanzerote and Las Palmas in the Canary Islands have shown that this genus has a different 2D chromatographic pattern compared to that of *Psoralea* and *Otholobium*. The flavonoids were mainly C-glycosides with a trace of quercetin (M. Boardley, Reading University, personal communication 1986). An unpublished study of the furanocoumarins and essential oils of collections of this species from the Canary Islands, Spain, Greece, Algeria, Italy and Israel revealed the presence of distinct chemical races (S. Arnot, M.Sc Reading University, 1984).

6.4. Conclusions

1. Isoflavonoid data would suggest that, from the unique occurrence of complex 6aH pterocarpans and 6a-hydroxy analogues, Psoraleeae are much more closely related to the tribes Phaseoleae and Desmodieae than to the Amorpheae. This provides a new character to separate amorphoid genera from psoraleoid genera. This correlates with seedling, pollen and nodulation data presented earlier.

2. Reciprocal averaging of the available chemical data on furanocoumarins, essential oils, flavonoids and proanthocyanidins of southern African Psoraleeae support the decision to split *Psoralea* into more than one genus.

3. Different classes of chemical compounds in Psoraleeae, from the same organ, have provided different levels of taxonomic information.

4. Furanocoumarins and flavonoids are most significant at the species level.

5. Essential oils and proanthocyanidins are most significant at the generic level. Essential oils are very uniform in *Psoralea* but are quite variable within *Otholobium* and may turn out to be important characters at the species level in this genus.

6. Isoflavones, which are entirely uniform within the group, are probably only meaningful at the tribal level.

7. The genus *Cullen*, represented by *C. obtusifolia* has no flavonoids in common with *Psoralea* and *Otholobium*.

CHAPTER 7

PALYNOLOGY

7.1 Introduction

Palynology has had a major impact on our understanding of plant phylogeny and has provided a wide range of characters that have been particularly useful at the suprageneric level (Walker & Doyle, 1976; Blackmore, 1984).

The pollen morphology of the tribe Psoraleeae was little known until recently (Ferguson & Skvarla, 1981; Ferguson & Skvarla, 1983; Ferguson, Furness and Stirton, 1989). These workers have shown that pollen characters are very useful at the tribal level but are not particularly helpful at the infra-tribal level.

The following sections will provide a brief overview of the pollen of the tribes Psoraleeae and Amorpheae and its use as a differentiating character, a summary of the pollen of the Psoraleeae and finally a few comments on pollen variation in *Otholobium*.

7.2 Pollen diversity in the tribes Psoraleeae and Amorpheae

The pollen morphology of Psoraleeae shows no affinity with Amorpheae (Ferguson & Skvarla, 1981). The differences between the two tribes are given in Table 7.1. The most striking diferences are features of the tectum, foot layer, endexine and especially the infratectum.

Table 7.1 Pollen characters which separate the tribes Psoraleeae and Amorpheae (Papilionoideae, Leguminosae).

POLLEN CHARACTERS	PSORALEEAE	AMORPHEAE
1. Tectum	coarsely reticulate	completely smooth, finely perforate or finely reticulate
2. Foot layer	absent	thin
3. Endexine	thick	thin
4. Infratectum	granular	columellar
5. Colpi	inoperculate	often operculate

The pollen of Psoraleeae is rather specialised and can be characterized as having the following features: large differentiated margo-colpi, very thick endexine, no foot layer, a highly specialised granular columellar layer and a thin tectum (Ferguson & Skvarla, 1981). Amorpheae, by contrast, have two distinct pollen types. In the more primitive woody genera *Apoplanesia* and *Eysenhardtia* the pollen grains are small, rather unspecialised, tricolporate, with a lalongate endoaperture, whereas in the more advanced herbaceous genera (*Dalea*, *Amorpha*, *Paryella* and *Petalostemon*) the pollen is more specialised with operculate colpi and an endoaperture which is a long interruption with diffuse lateral thinnings (Ferguson & Skvarla, 1981).

The development of a very thick endexine and the almost complete loss of the foot layer are two features that are shared by the tribes Phaseoleae and Desmodieae. In Psoraleeae the foot layer is absent but a thick endexine is developed and the tectum is essentially granular compared to the more columellate Phaseoleae and Desmodieae. Once again, together with Loteae and Indigofereae, these tribes share pollen features which indicate affinity. This agrees with data presented in earlier chapters in which the above tribes had the same types of seedlings, nodules, inflorescence structure (pseudoracemes) and the presence of pterocarpans. The Amorpheae, by contrast, share more pollen features with the tribes Sesbanieae, Adesmieae and some Aeschynomeneae than with the Psoraleeae grouping (Ferguson & Skvarla, 1981).

Pollen evidence supports Barneby's (1977) separation of the Amorphoid genera from Hutchinson's (1964) broad-based Psoralieae into a distinct tribe Amorpheae.

7.3 **Pollen variation within the tribe Psoraleeae**

A detailed EM (12 spp.), SEM (60 spp.) and light microscopic (130 spp.) study of pollen diversity in the tribe Psoraleeae is currently underway (Ferguson, Furness & Stirton, 1987 - 1989). I will not refer to the data of this study save to say that preliminary observations would suggest that pollen characters are not very significant at the generic level but may be of some use in characterizing a small number of species, for example, *Cullen walkingtonii*. This species has the largest pollen grains in the tribe and a somewhat different tectum to that found in other species of Australasian Cullens. This species is unique in the tribe in having large reddish flowers and is reported to be visited by birds. Ferguson (1984) was the first person to correlate variable exine ornamentation in various legume genera with different types of pollinators (eg., bird/bat flowers versus insect flowers) in species pairs in *Camoensia*, *Millettia*, *Templetonia* and *Erythrina* (Hemsley & Ferguson, 1985).

Published accounts of the pollen of *Psoralea* sensu lato include *Psoralea (Rupertia) glandulosa* (Heusser, 1971), *P. (Cullen) corylifolia* (Vishnu-Mittre & Sharma, 1962), and *P. (Cullen) parva* (Ferguson & Skvarla, 1981). Vishnu-Mittre and Sharma (1962) refer to the distinctive 3-zoniporate type of pollen which they found consistently in *Psoralea* s.l., their *P. corylifolia* type, and elsewhere only in the primitive species of *Eriosema*, *E. chinense* Vog. All the other species of subtribe Cajaninae of the Phaseoleae have 3-zoni-colporate pollen.

Pollen size is correlated with flower size in Psoraleeae. For example, the range in pollen size in the two subgenera of *Psoralea* and of *Otholobium* is shown in Fig. 7.1. Subgenus *Psoralea* has flowers 2 -- 5 times larger than those in subgenus *Hallia*. The flowers

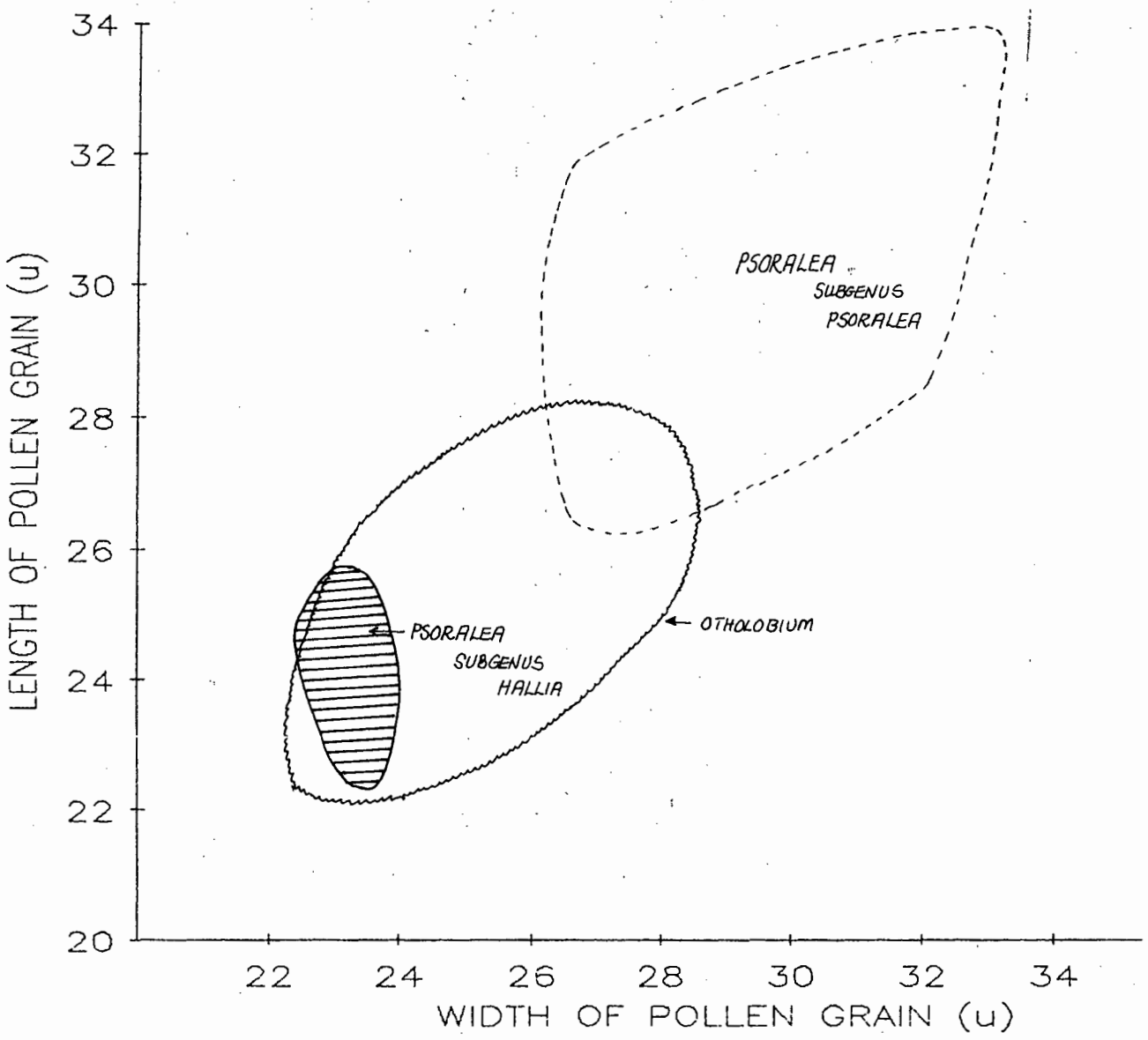


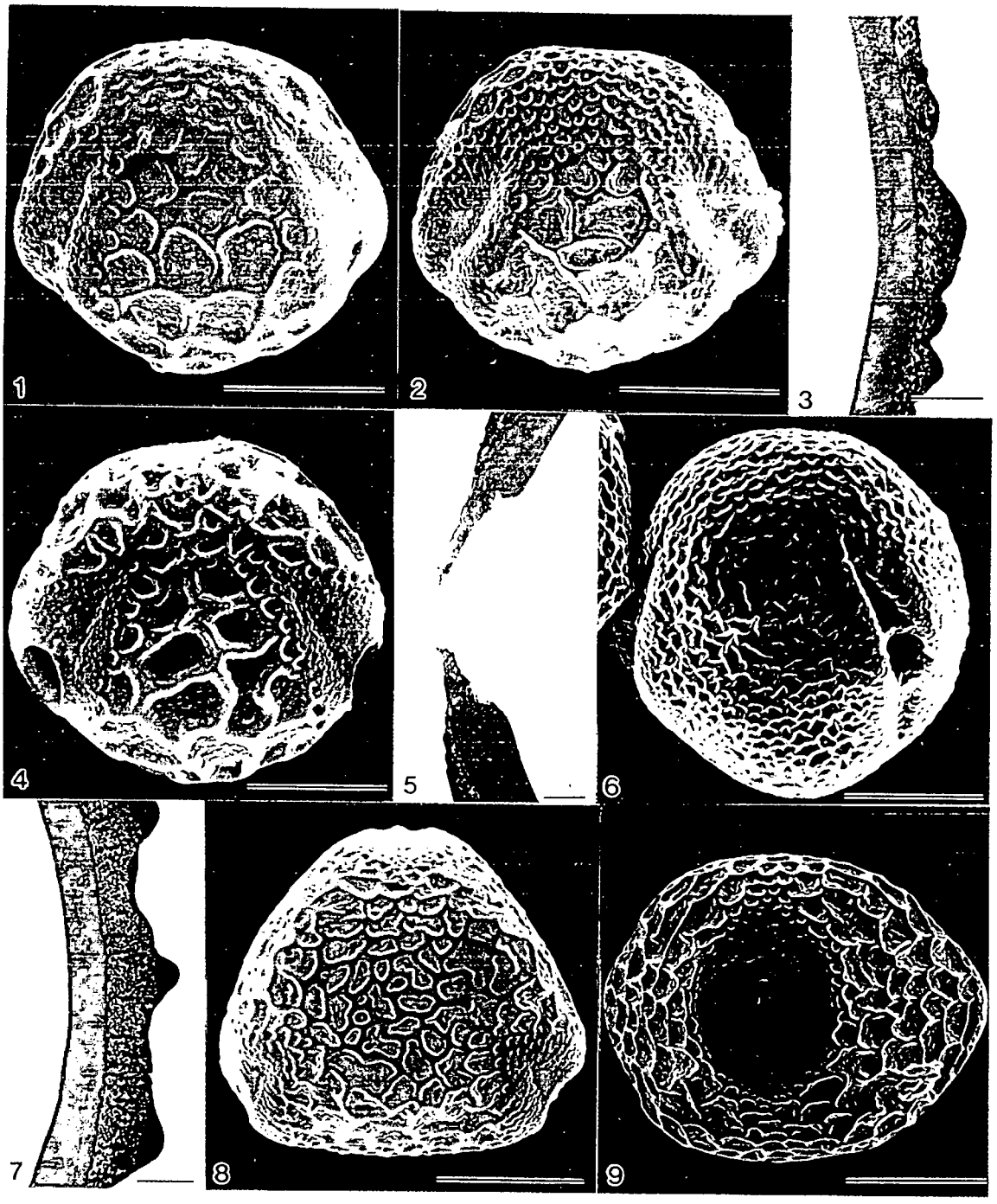
Fig 2.1 Range of pollen size in the two subgenera of *Psoralea* and *Otholobium* (Length vs. breadth of pollen grains). Based on 90 species (Ferguson, Furness & Stirton, unublished).

of *Otholobium* are smaller than in *Psoralea* but usually larger than those of subgenus *Hallia*. The pollen of *Psoralea* subgenus *Psoralea* is much larger than both *Otholobium* and *Psoralea* subgenus *Hallia*.

We have studied the pollen of 36 species of *Otholobium*, representing 69% of the genus. There is little information of taxonomic value; the features overlap broadly with other genera of the tribe and the tectal variation which occurs within the genus is paralleled in other groups. The following characterization of pollen variation in *Otholobium* was kindly provided by Carol Furness, Royal Botanic Gardens, Kew:

The pollen of *Otholobium* has a polar diameter of (20) 27.1 (36) µm and an equatorial diameter of (20) 27.9 (36). The shape is subspheroidal (ranging from suboblate to subprolate) or spheroidal. The apertures are 3-colporate and the colpi have prominent thickened margines except in *O. bolusii* (Fig. 7.2,4) and *O. rotundifolium* (Fig. 7.2,6). The colpi extend to the apocolpium in most cases although shorter copli occur in *O. spicatum*, *O. spissum*, and *O. zeyheri* (Fig. 7.2,9). The endoaperture is a circular ora. In TEM thinning of the endexine at the aperture is visible (Fig. 7.2,5). The sculpturing is reticulate to very coarsely reticulate on the mesocolpia with either a polar cap, for example, in *O. hamatum* (Fig. 7.2,1) or a finer reticulum at the apocolpium, for example, in *O. bolusii* (Fig. 7.2, 4). An exception is *O. zeyheri* (Figs. 7.2,8 & 9) which is uniformly reticulate with no differentiation at the poles. Areas of solid tectum in the centre of the mesocolpia are absent in *Otholobium* pollen although they occur in other members of Psoraleeae including some species of *Psoralea*. The wall stratification in TEM sections is tectate with a granular ectexine and thick endexine; these features are a unifying feature throughout the tribe.

Fig. **7.2 Pollen features of the genus** *Otholobium*. **1,** *Otholobium hamatum* (Harv.) C.H. Stirton (*Pearson 5864*), SEM of whole pollen grain showing coarsely reticulate mesocolpium and polar cap of perforate tectum. Scale line = 1μm; **2,** *O. bowieanum* (Harv.) C.H. Stirton (*Hugo 595*), SEM of whole grain showing coarsely reticulate mesocolpium and polar cap of finely reticulate tectum. Scale line = 10μm. **3,** *O. hamatum* (Harv.) C.H. Stirton (*Pearson 5864*), TEM of a section through the exine showing granular ectexine and thickened endexine. **4,** *O. bolusii* (Forbes) C.H. Stirton (*Acocks 19695*), SEM of whole grain showing coarsely reticulate mesocolpium and reticulate apocolpium. Scale line = 10μm. **5,** *O. acuminatum* (Lam.) C.H. Stirton (*Thom 489*), TEM of a section through an aperture showing thinning of the endexine. Scale line = 1μm. **6,** *O. rotundifolium* (L.f.) C.H. Stirton (*Taylor 6666*), SEM of whole grain showing mesocolpium with line of reticulate sculpturing and polar cap of perforate tectum. Scale line = 10μm. **7-9,** *O. zeyheri* (Harv.) C.H. Stirton (*Boucher 2023*). **7,** TEM of a section through the exine showing granular ectexine and thin endexine. Scale line = 10μm. **8,** SEM, polar view, with reticulate sculpturing and short colpori. Scale line = 10μm. **9,** SEM, equatorial view, showing short colporate aperture and reticulate sculpturing. Scale Line = 10μm.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7.4. Conclusions

1. Pollen features of the genera included in the tribe Psoraleeae Stirton emend. are quite different from those of the tribe Amorpheae and do not indicate any close affinity as had been previously supposed.

2. Pollen data provide little taxonomic evidence at the species or generic level.

CHAPTER 8

CONSERVATION BIOLOGY AND SYSTEMATICS

8.1 Introduction

During the last decade there has been a renewed interest in the conservation status of species and the habitats they occupy (Adamus & Clough, 1978; Bratton & White, 1980; Drury, 1980; Jenkins, 1975; Massey & Whitson, 1980; Simmons, Beyer, Brandham, Lucas & Parry, 1976; Stebbins, 1980; Walters, 1981; Lucas & Synge, 1981). Central to this awareness has been a concerted attempt to define and standardize a concept of rarity (Harper, 1981).

Numerous definitions of rarity have been proposed by many different authors (Ayensu, 1981; Good & Lavarack, 1981; Lucas & Synge, 1981) but with little agreement. This is to be expected as species may become rare by several pathways (Bratton & White, 1981). Likewise, if rarity has a variety of causes then the evolutionary and ecological consequences of rarity may be equally diverse (Rabinowitz, 1981).

The broadening professionalism of biological conservation has seen a shift in emphasis in published works from description and biopolitics to more scientific and empirical studies (Brown, 1979; Hamrick, Linhart & Mitton, 1979; Gottlieb, 1981; Markert, 1983; Whitt, 1983; Loveless & Hamrick, 1984). The earlier papers stimulated widespread concern about the global loss of biotic diversity. However, it has taken

some time for this concern to be translated into the type of information which systematists might use to assess the conservation status of the species they may be revising.

The empirical side of biological conservation has emerged to some extent from the work done by population geneticists interested in microevolution. Much of this work has centred on allozymic analysis of small populations. Earlier studies wrestled with the problems of homology and the usefulness of the data in phenetic and cladistic studies. The availability of cheaper and more efficient electrophoretic techniques, together with a better understanding of the value of the data should soon enable systematists to undertake such studies themselves and not have to rely on population geneticists to generate the data. The promises and pitfalls of using electrophoretic data (allozymes and isozymes) in systematic and evolutionary studies has been reviewed by Avise (1974), Gottlieb (1981), Buth (1984) and Grant and Robinson (1989).

A recent development is the shift away from a comparison of the polymorphisms of geographically grouped taxa to more specific comparisons between restricted and widespread congeners (Kruckeberg & Rabinowitz, 1985) coupled with breeding systems studies (Karron, 1987a; 1987b). The need for such ecological and genetic studies to enhance sound management of species, populations and habitats has been stressed by Soulé & Wilcox (1980), Shaffer (1981), Soulé (1986) and others.

8.2 **Plant systematists and their use of conservation data**

A number of questions could be asked by systematists of conservation data:

1. How reliable is the data that is currently stored in conservation databanks?
2. What proportion of the available data has been provided or checked by systematists?
3. What is the quality of the data that has been gathered so far?
4. How useful is the data for providing practical guidelines for the conservation of species?
5. Is there any information of practical value that systematists may offer to professional conservationists to enable them to improve the quality of their data?

In attempting to answer some of these questions and mindful that it may have been systematists who provided much of the earlier data on the conservation status of plants, I propose in this chapter to outline my own experience in using the data which has accumulated during the last decade.

Before I do this this I would like to clarify my working rationale and classification of rarity. This is expressed adequately in Rabinowitz's (1981) typology of rarity. She precedes her classification of flexible categories of rarity with the following paragraph:

"This classification of rarity differs from the others in this book ....for three fundamental reasons. First, the aim of drawing up a list of species is not imposed upon me, and so I need not employ the categories to fulfil a legal charge. Secondly, no specific taxa, geographical locality, or administrative units need be kept in mind. Thirdly, the endangered or threatened status of plants is not my central concern. These factors free me from the constraints of pragmatism, and this may contribute

some clarity in exploring the biological consequences of rarity. Hopefully the exercise will permit some new perspectives for people engaged in more practical concerns."

I begin with my experience in dealing with requests to comment on data gathered in various computerized plant databases. My intention was to check primarily for nomenclatural accuracy, secondarily to append omitted taxa and generally to evaluate the conservation ranking allocated to existing species in the databases.

In the sections that follow I will refer to three such databases and will comment on the contents of each in turn. It will become clear, I hope, that the criteria used by the database originators in selecting species for initial entry into their respective databases may be less reliable than users might have supposed. I will also show that the Internationally accepted IUCN categories are not particularly meaningful for either exploring the biological consequences of rarity (Rabinowitz, 1978) or providing accurate enough estimates for practical conservation measures. Finally I will argue that the model proposed by Rabinowitz (1981) and modified by Karron (1987a) and myself may be of more practical use to field-oriented systematists in helping them collate their subjective knowledge of the plants they study than would otherwise be the case if they adopted existing conservation categories. In this way systematists may provide a valuable second tier of conservation data.

I will end this chapter with a short profile on the conservation status of 106 species of African Psoraleoid legumes which may be of practical interest to evolutionists, conservationists, ecologists, biologists and others. I have drawn a number of conclusions which I hope might be starting points for future empirical studies.

8.3 The IUCN conservation status categories

The IUCN categories of conservation status used by a wide range of country specific red-data books on plants are reproduced in Table 8.1. They are extracted from the pamphlet *How to use the IUCN Red Data Categories* published by the Threatened Plants Committee Secretariat (1980). These categories are used to indicate the degree of threat to individual species in their wild habitats and are used in the sections that follow.

8.4 Analyses of lists of the tribe Psoraleeae obtained from three different conservation databases

To test the validity of the data held in conservation databases I obtained three listings of rare and endangered species of the tribe Psoraleeae (Papilionoideae, Leguminosae). The publications and listings used were:

1. IUCN Threatened Plants Database (8th November, 1987 listing). **THRPLANT.**
2. South African Red Data Book, Plants - Fynbos and Karoo Biomes (Hall & Veldhuis, 1985). **SARDB-1.**
3. Threatened Plants of Southern Africa (Hall, de Winter, de Winter and Oosterhout, 1980). **TPSA.**

The latter two databases are restricted to southern Africa, the area of immediate concern to this investigation as it contains over 98% of the species belonging to the two genera *Otholobium* and *Psoralea*.

Table 8.1 Red Data Book categories used by the International Union for the Conservation of Nature (Threatened Plants Committee Secretariat, 1980).

EXTINCT (Ex) - This category is only used for species which are no longer known to exist in the wild after repeated searches of the type localities and other known or likely places.

ENDANGERED (E) - Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating. Included are taxa whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction.

VULNERABLE (V) - Taxa believed likely to move into the endangered category in the near future if the causal factors continue operating. Included are taxa of which most or all the populations are decreasing because of over-exploitation, extensive destruction of habitat or other environmental disturbances; taxa with populations that have been seriously depleted and whose ultimate security is not yet assured; and taxa with populations that are still abundant but are under threat from serious adverse factors throughout their range.

RARE (R) - Taxa with small world populations that are not at present Endangered or Vulnerable but are at risk. These taxa are usually localized within restricted geographical areas or habitats or are thinly scattered over a more extensive range.

INDETERMINATE (I) - Taxa known to be Extinct, Vulnerable or Rare but where there is not enough information to say which of the four categories is appropriate.

Insufficiently Known (K) - Taxa that are suspected but not definately known to belong to any of the above categories because of lack of information.

OUT OF DANGER (O) - Taxa formerly included in one of the above categories, but which are now considered relatively secure because effective conservation measures have been taken or the previous threat to their survival has been removed.

(nt) - The symbol nt is used for species which are neither rare nor threatened.

8.4.1 **List 1: Threatened Plants of Southern Africa (TPSA)**

The first listing of threatened plants in southern Africa was published in 1980 by Hall *et al.* The Leguminosae covered in this report are listed in Table 8.2. It was produced to assist conservation authorities in the region and to provide lists for the International Union for the Conservation of Natural Resources (IUCN). The list deals with the area covered by the Flora of Southern Africa project and includes all of continental southern Africa south of (but excluding) Angola, Zimbabwe and Mocambique.

Table 8.2 lists 81 species of the family Leguminosae. 18,5% of these species are non-endemic to the region. Unfortunately, the report does not list any species of *Psoralea.*

8.4.2 **List 2: South African Red Data Book: Plants - Fynbos and Karoo biomes (SARDB-1).**

The second major report on the threatened plant problem in southern Africa was published in 1985 by Hall and Veldhuis. The area covered in this report is considerably smaller than that studied by Hall *et al.* (1980) yet is considered to be one of the richest areas of species diversity in the world (Bond & Goldblatt, 1984). It includes the region of the Cape Province south of the Orange River and westward from the 26 degree line of longitude which lies adjacent to Port Elizabeth. The report does not list species by family as did the earlier report but does so by biogeographic zone; a particularly invaluable innovation.

Table 8.2 Threatened Leguminosae of Southern Africa (Hall et al., 1980).

LEGUMINOSAE	SOUTHERN AFRICA	ENDEMIC /NON-ENDEMIC	WORLD
Acacia hebeclada ssp. chobiensis	R	ne	R
A. hebeclada ssp. tristis	R	e	R
A. montis-usti	R	e	R
A. robynsiana	R	e	U
A. welwitscii	R	ne	nt
Albizia amara	U	ne	nt
A. antunesiana	U	ne	nt
A. suluensis	R	e	R
Amblygonocarpus andongensis	U	ne	nt
Aspalathus acanthiloba	U	e	U
A. acanthophylla	I	e	I
A. aciloba	U	e	U
A. arenaria	U	e	U
A. barbigera	I	e	I
A. bidouwensis	I	e	I
A. borbonifolia	R	e	R
A. burchelliana	U	e	U
A. campestris	U	e	U
A. candidula	U	e	U

Table 8.2 (contd.).

LEGUMINOSAE	SOUTHERN AFRICA	ENDEMIC /NON-ENDEMIC	WORLD
Aspalathus compacta	U	e	U
A. comptonii	R	e	R
A. concava	U	e	U
A. corniculata	U	e	U
A. decora	U	e	U
A. desertorum	R	e	R
A. digitifolia	U	e	U
A. erythrodes	U	e	U
A. esterhuyseniae	R	e	R
A. excelsa	R	e	R
A. fasciculata	R	e	R
A. ferox	U	e	U
A. florulenta	U	e	U
A. fourcadei	U	e	U
A. glabrata	I	e	I
A. glossoides	U	e	U
A. grobleri	U	e	U
A. hypnoides	U	e	U
A. incana	U	e	U

Table 8.2 (contd.).

LEGUMINOSAE	SOUTHERN AFRICA	ENDEMIC /NON-ENDEMIC	WORLD
Aspalathus karrooensis	U	e	U
A. lamarckiana	U	e	U
A. latifolia	U	e	U
A. lenticula	U	e	U
A. longifolia	U	e	U
A. macrantha	U	e	U
A. macrocarpa	U	e	U
A. obliqua	U	e	U
A. obtusifolia	U	e	U
A. odontoloba	U	e	U
A. orbiculata	U	e	U
A. pallescens	U	e	U
A. pilantha	U	e	U
A. prostrata	U	e	U
A. quadrata	U	e	U
A. ramosissima	U	e	U
A. rectistyla	U	e	U
A. rostrata	U	e	U
A. rycroftii	V	e	V

Table 8.2 (contd.).

LEGUMINOSAE	SOUTHERN AFRICA	ENDEMIC /NON-ENDEMIC	WORLD
Aspalathus smithii	V	e	V
A. stokoei	R	e	R
A. suaveolens	R	e	R
A. sulphurea	U	e	U
A. vaccinifolia	U	e	U
A. variegata	X	e	X
A. vulpina	U	e	U
Bauhinia bowkeri	R	e	R
Calpurnia robinioides	R	e	R
C. woodii	R	e	R
Cordyla africana	R	ne	nt
Craibia zimmermannii	R	ne	nt
Dialium schlechteri	R	ne	nt
Elephantorrhiza praetermissa	U	e	U
E. sp.	U	e	U
Entada pursaetha	R	ne	nt
Erythrina decora	R	e	R
Guibourtia conjugata	R	ne	nt
Kotschya thymadora	R	ne	nt

Table 8.2 (contd.).

LEGUMINOSAE	SOUTHERN AFRICA	ENDEMIC /NON-ENDEMIC	WORLD
Liparia splendens	U	e	U
Sophora inhambanensis	R	ne	R
Umtiza listerana	R	e	R
Xeroderris stuhlmannii	R	ne	nt
Xylia torreana	R	ne	nt
		Total = 81	

The 106 species (13 genera) of Leguminosae listed in SARDB-1 are reproduced in Table 8.3. This appears to increase the number of legume species threatened in South Africa by 25 species. However, as the following list indicates SARDB-1 and TPSA differ radically in the legume genera each cover. The following genera occur in TPSA but do not occur in SARDB-1:

Acacia (5), *Albizia* (3), *Amblygonocarpus* (1), *Bauhinia* (1), *Calpurnia* (2), *Cordyla* (1), *Craibia* (1), *Dialium* (1), *Elephantorrhiza* (2), *Entada* (1), *Erythrina* (1), *Guibourtia* (1), *Kotschya* (1), *Sophora* (1) *Umtiza* (1), *Xeroderris* (1) and *Xylia* (1).

Nearly all of these genera are eastern summer rainfall genera so would not have been expected to be covered in SARDB-1. However, TPSA failed to record any species from the following predominantly Cape centred (*) genera:

Calliandra (*1), *Crotalaria* (1), *Cyclopia* (*5), *Indigofera* (1), *Lebeckia* (*1), *Lessertia* (*3), *Lotononis* (*4), *Otholobium* (*2), *Polhillia* (*1), *Podalyria* (*2), *Priestleya* (*12), *Psoralea* (*8) and *Rafnia* (*2).

SARDB-1 added 8 species of *Aspalathus* to those listed by TPSA.

In analysing the SARDB-1 it is evident that there has not been a critical taxonomic input in assessing the conservation status of threatened Leguminosae of the region. It is inconceivable, for example, that the genus *Indigofera*, with over 250 species in South Africa, should only be represented in the list by two species. I have collected the majority of the species in this genus as well as a number of undescribed species and am familiar with the general ranges and habitat tolerances of a large number of

Table 8.3 List of legumes extracted from Hall & Veldhuis (1985); listing species, conservation status and habit (some comments, based on my field experience, are given in angled brackets).

SPECIES NAME	IUCN CONSERVATION CATEGORY	HABIT
Aspalathus acanthiloba	U	shrublet
A. acanthophylla	U	shrublet
A. aciloba	U	shrublet
A. arenaria	CR	shrub
A. barbigera	E	shrub
A. bidouwensis	I	shrublet <treelet>
A. borbonifolia	CR	shrublet
A. bowieana	U	shrub
A. burchelliana	V	shrub
A. campestris	U	shrublet
A. candidula	U	shrublet
A. compacta	U	shrublet
A. comptonii	CR	shrublet
A. concava	U	shrublet
A. corniculata	U	shrublet
A. decora	U	shrub
A. desertorum	CR	shrub
A. digitifolia	CR	shrub
A. erythrodes	U	shrublet

Table 8.3 (contd.).

SPECIES NAME	IUCN CONSERVATION CATEGORY	HABIT
Aspalathus esterhuyseniae	CR	shrublet
A. excelsa	CR	<shrub>
A. fasciculata	CR	shrub
A. ferox	U	shrub
A. florulenta	U	shrublet
A. fourcadei	U	shrub
A. glabrata	I	shrublet
A. globulosa	I	shrublet
A. glossoides	U	shrublet
A. grobleri	E	shrublet
A. hypnoides	U	shrublet
A. incana	U	shrublet
A. karroensis	U	shrublet
A. lamarckiana	U	shrub
A. latifolia	U	shrub
A. lenticula	U	shrublet
A. longifolia	U	shrub
A. macrantha	I	shrub
A. macrocarpa	U	shrublet

Table 8.3 (contd.).

SPECIES NAME	IUCN CONSERVATION CATEGORY	HABIT
Aspalathus obliqua	U	shrublet
A. obtusifolia	U	shrublet
A. odontoloba	U	shrublet
A. oliveri	CR	shrub
A. orbiculata	U	shrub
A. pilantha	U	shrublet
A. prostrata	E	shrublet
A. quadrata	U	shrublet
A. ramosissima	U	shrub
A. rectistyla	U	shrublet
A. rosea	CR	shrublet
A. rostrata	U	shrub
A. rycroftii	E	shrublet
A. smithii	V	shrublet
A. spectabilis	CR	shrub
A. stokoei	CR	shrub
A. suaveolens	CR	shrublet
A. sulphurea	U	shrublet
A. truncata	U	shrub

Table 8.3 (contd.).

SPECIES NAME	IUCN CONSERVATION CATEGORY	HABIT
Aspalathus vaccinifolia	U	shrublet
A. variegata	E	shrublet
A. venosa	CR	shrub
A. vulpina	U	<shrublet>
Calliandra redacta	CR	shrub
Crotalaria lebeckioides	U	shrub
Cyclopia bowieana	I	shrub
C. burtonii	I	shrub
C. filiformis	U	shrub
C. longifolia	U	shrub
C. pubescens	U	shrub
Indigofera hispida	U	shrub
I. superba	CR	shrub
Lebeckia bowieana	U	shrublet
Lessertia carnosa	U	shrublet
L. globosa	I	herb
L. kensitii	U	perennial herb
Liparia splendens	U	shrub
Lotononis macra	CR	shrublet

Table 8.3 (contd.).

SPECIES NAME	IUCN CONSERVATION CATEGORY	HABIT
Lotononis pallens	U	shrublet
L. viborgioides	CR	shrublet
L. villosa	U	shrublet
Otholobium pungens	CR	shrub
O. rubicundum	U	shrub
Podalyria cordata	V	shrub
P. tayloriana	V	shrub
Polhillia waltersii	I	shrub
Priestleya elliptica	I	shrub
P. glauca	I	shrub
P. guthrei	U	shrub
P. laevigata	U	shrub
P. leiocarpa	U	shrub
P. myrtifolia	U	shrub
P. rogersii	U	shrub
P. schlechteri	U	shrub
P. stokoei	I	shrub
P. tecta	CR	shrub
P. thunbergii	U	shrub

Table 8.3 (contd.).

SPECIES NAME	IUCN CONSERVATION CATEGORY	HABIT
Psoralea bolusii	I	shrub
P. glaucinia	I	shrub
P. keetii	U	shrub
P. macradenia	I	shrub
P. odratissima	U	shrub
P. patersoniae	U	shrub
P. striata	U	shrub
P. venusta	I	shrub
Rafnia crispa	I	perennial herb
R. ericifolia	I	shrublet
		Total number of species = 106

species. I believe that most of the narrow endemics of the Southern Coastal Mountain Region (Map 5 of Hall & Veldhuis, 1985), especially of the Elim Dwarf Fynbos and Soetanysberg Fynbos Limestone areas, are particularly endangered. In mitigation, the authors of SARDB-1 do stress that the reliability of threatened plant surveys are essentially dependent on the production of good floristic or monographic revisions, persistence in hunting for remnant plants in largely disturbed and altered habitats and finally having to cope with the patchiness of collection of herbarium vouchers. The latter topic has been covered by Gibbs Russell (1985) who published a map of collecting intensity in southern Africa.

Hall and Veldhuis (1985) make the pertinent observation that from their point of view it was fortunate that many of the dominant families of the fynbos region had been studied intensively and recently in the field. The families Restionaceae, Ericaceae and Iridaceae accordingly feature strongly. Apart from some Asteraceae, Mesembryanthemaceae, Poaceae, and Euphorbiaceae the report is rather thin on many of the other families such as the Leguminosae, Liliaceae *sensu lato*, Amarylidaceae, Poaceae and Apiaceae which are seriously endangered in many areas. One must assume that either the taxonomists working on these families were not consulted in the compilation of the report or there were no experts available for some groups. This is certainly the case for the Leguminosae as the next section will indicate. The *implications* are that the endangered status of the South African vegetation is considerably more serious than either of the above two reports have indicated. Two extinct species, for example, which have not been included in either reports are *Psoralea guenzii* Harv. and *P. cataracta* Stirton.

It is not my intention here to investigate all of the data on Leguminosae contained in the two reports on southern African plants referred to above. Rather, I will restrict myself to *Otholobium* and to its sister group *Psoralea*.

The species of *Psoralea* listed on page 85 of SARDB-1 should be altered as follows:

1. *P. bolusii*, *P. macradenia*, *P. striata* and *P. venusta* have all been transferred to *Otholobium* (Stirton, 1986; published after their report).
2. *P. glaucinia* (should read *P. glaucina*), *P. keetii* and *P. odoratissima* all remain in *Psoralea*.
3. *P. patersoniae* is an introduction into the country so should be deleted from the list. It is a synonym of *Cullen corylifolia*.
4. The two species of *Otholobium* listed on page 77 remain in *Otholobium*.

What about the accuracy of the data recorded for each of the species mentioned above?

1. *Otholobium bolusii* (Indeterminate), *O. rubicundum* (Uncertain), *P. venustum* (=*Otholobium*; Indeterminate), *Psoralea keetii* (Uncertain) and *P. odoratissima* (Uncertain) should be altered to Vulnerable.
2. *Otholobium macradenium* (Indeterminate) and *P. glaucina* (Indeterminate) should be altered to Critically Rare.
3. *Otholobium pungens* (Critically rare) should be altered to endangered.

4. *Psoralea patersoniae* should be omitted from the list. This species was introduced as an ornamental into South Africa early this century from Europe. It escaped from cultivation and although it was described as new (Schonland, 1914) it has not persisted in the wild. Concerted efforts by a number of local botanists as well as myself to find it have been unsuccessful. It appears not to have persisted as a ruderal (Stirton, 1981).

5. I may also comment on one legume and one non-legume species. The apiaceous species *Apium inundatum* (Indeterminate), an introduced species of rare persistence, should also be removed from the list. *Aspalathus bidouwensis*is a **small tree** when mature with stems up to 200 mm at the base. I am aware of only one grove of mature trees. Saplings of this species exist in a few other localities. All populations are under severe threat from overgrazing.

8.4.3. List 3: IUCN list of *Psoralea* sensu lato in the Threatened Plants Database (THRPLANT)

The IUCN Threatened Plants Database contained on the 8 November 1987 eleven species of *Psoralea* world-wide (Table 8.4). None of the species contained in the Hall & Veldhuis (1985) list were listed in this database which indicated an entry or update lag of nearly two years. However, see below for the possible reason.

Here I address the question whether the THRPLANT list offers any improvements over the SARDB-1 and TPSA lists. I do not believe so. It lists only 5% of the known species of the tribe Psoraleeae worldwide and records no extinctions. Of the

Table 8.4 IUCN List of Psoralea in the Threatened Plants Database (8th November, 1987).

8 November 1987 — IUCN list of Psoralea in the Threatened Plants Database —

Plant name	Distribution (Cons. status) (Data-source)	1	2	3	4	5	6	7	8
ANGIOSPERMAE									
LEGUMINOSAE									
Psoralea archeri F.Muell.	N. Territory (?), W. Australia (?)	?	?	B					
Psoralea epipsila Barneby	Arizona (I), Utah (I)	I	I	B		?		C	
Psoralea flaccida Nabelek	Jordan (?)(8895)	?	?	A	8895				
Psoralea macrophylla Rowlee ex Small	N. Carolina (E)	E	E	A				C	
Psoralea odorata Blatter & Hallberg	Pakistan (?)(7771), Rajasthan (I)(7771)	?	?	B	7771	Y			
Psoralea pariensis Welsh ex Atw.	Utah (I)	I	I	A				C	
Psoralea parva F.Muell.	S. Australia (?), Victoria (E)	E	E	B		Y			
Psoralea rydbergii Cory	Texas (I)	I	?	C		?		C	
	Mexico (?)	?							
Psoralea stipulata Torrey ex A.Gray	Indiana (E), Kentucky (E)	E	E	B		?		C	
Psoralea trinervata (Rydb.) Standley	New Mexico (I), Texas (I)	I	?	C		?		C	
	Mexico (?)	?							
Psoralea walkingtonii F.Muell.	N. Territory (?), W. Australia (?)	V	V	B					

INDEX OF DATA SOURCES

7771 Jain, S.K., Rao, R.R. (1983). An assessment of threatened plants of India. Botanical Survey of India. 334p. Proc.of the Seminar held at Dehra Dun. 14-17 Sept., 1981.

8895 Zohary, M. et al . (1966). Flora Palaestina. Jerusalem, Israel Academy of Sciences. [Notes: 3 vols so far.]

EXPLANATION OF FIELDS LABELLED 1 TO 8

1. Regional IUCN Red Data Book category for the degree of threat. Ex: Extinct; E: Endangered; V: Vulnerable; R: Rare; I: Indeterminate; K: Insufficiently known; C: Candidate; ?: no data; nt: neither rare nor threatened.

2. World IUCN Red Data Book category for the degree of threat. Ex: Extinct; E: Endangered; V: Vulnerable; R: Rare; I: Indeterminate; K: Insufficiently known; C: Candidate; ?: no data; nt: neither rare nor threatened.

3. Endemism code. A: confined to one CMC area; B: More than one CMC area; C: more than one TPU region; D: Doubtfully endemic to one CMC area; ?: unknown.

4. Data source for Plant Name - see preceding list.

5. Distribution completeness code. Y: Distribution complete; N: Distribution incomplete; ?: Not known whether distribution complete; Space: Taxon confined to one CMC area.

6. Address in TPU database of text file.

7. Category under the U.S. Endangered Species Act. E:Endangered; T: Threatened; P: Formally proposed for listing; C: Candidate

8. Life form. T: Tree; H: Herb; S: Shrub (only partly implemented).

species listed only two species have been sourced to publications and both (*Psoralea odorata* Blatter & Hallberg and *P. flaccida* Nábélek) are certainly synonymous with *Bituminaria bituminosa* (L.) Stirton. Greuter in Greuter and Raus (p.108, 1986) recently erroneously transferred two taxa to *Bituminaria*: *B. flaccida* (Nábélek) Greuter and *B. morisiana* (Pignatti & Matlesics) Greuter. Both are minor splits from *B. bituminosa.*

8.4.4 Comparison of data in the Threatened Plants Database (THRPLANT) and Hall *et al.* (1985) (SARDB-1).

It seemed appropriate, given that I was comparing the treatment of *Psoralea* in the selected databases, that I should compare the overall congruence of IUCN's THRPLANT data with SARDB-1. I am grateful to Ms. Christine Leon (IUCN - Threatened Plants Unit) who provided me with Table 8.5 which is a comparison of the number of species by category in each of the databases.

There were no species which were in both databases and which had different categories. As might be expected THRPLANT had many more species that were not threatened or insufficiently known. What is surprising is the number of taxa falling into the Ex, E, V and R categories: 822 (45,5%) for SARDB-1 versus 39 (11,2%) in THRPLANT.

Another interesting comparison is that there are 28 extinctions recorded in SARDB-1 but none in THRPLANT.

Table 8.5 Comparison of Red Data Book Categories used in THRPLANT and SARDB-1 (Data courtesy of Ms. Christine Leon, Threatened Plants Unit, IUCN).

```
WORKSTATION  5  -  USER LEO  -  Christine Leon

 5:13:26 pm    Friday        November 20, 1987
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                    Plant 'Red Data Book' Conservation Status Categories

 Short name: Hall & Veldhuis                          Area covered: Cape Prov.

 Ref: Hall, A.V., Veldhuis, H.A. (1985). South African Red Data Book: plants -
      Fynbos and Karoo Biomes.  South African National Scientific Programmes
      Report No. 117. 160 p.

 Book Category   Short  IUCN  CT DL Comments
 Extinct         X      Ex    A  N
 Endangered      E      E     A  N
 Vulnerable      V      V     A  N
 Critically rare R      R     A  N
 Indeterminate   I      I     A  N
 Uncertain       U      K     A  N
 Not threatened  nt     nt    A  N
 Not in book     ?      ?     A  N  No category in print
 ____________    _____  _____ _  _
 ____________    _____  _____ _  _
 ____________    _____  _____ _  _
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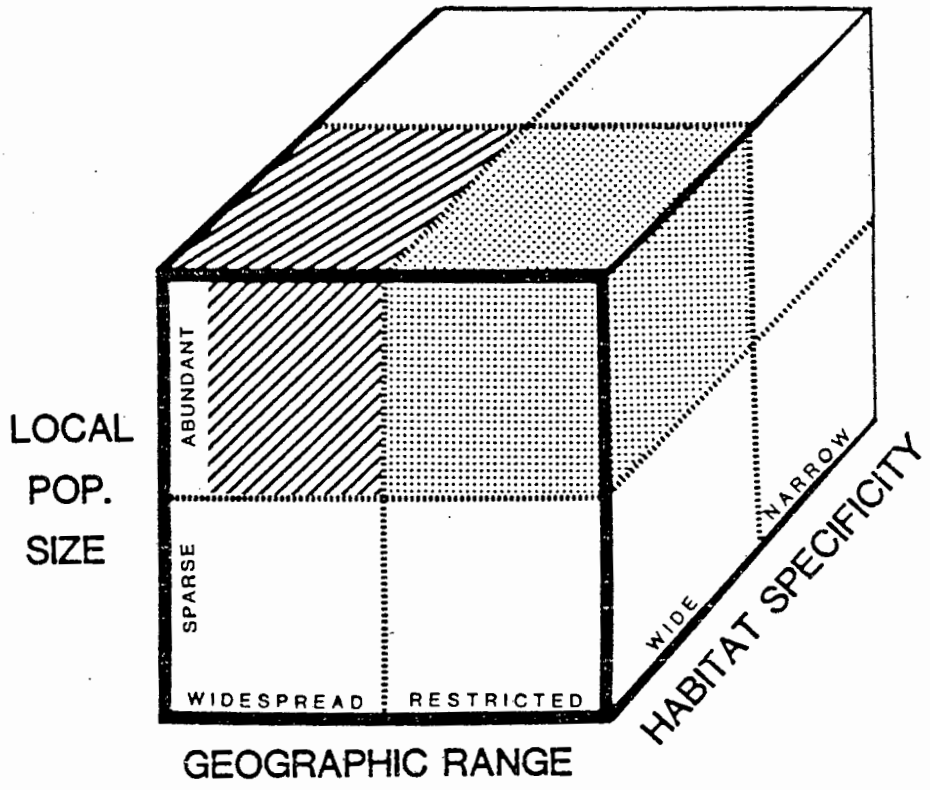

Fig. 8.1 A classification scheme for different types of rarity in plants (After Karron, 1987). The three variables (local population size, geographical range and habitat specificity) form an 8-cell matrix (modified from Rabinowitz, 1981).

These statistics highlight the importance of local Red Data lists in upgrading centralised databases. SARDB-1 and other local Red Data lists are now incorporated in another IUCN database called PLANTS thereby giving a more accurate worldwide estimation.

These points notwithstanding it is also evident that all the nomenclatural and orthographic errors produced in SARDB-1 are taken up uncritically in PLANTS. I have not been able to ascertain whether this would apply to other Red Data lists taken up into PLANTS but it is a potential source of error. It suggests that there has not been any quality control in transferring data between the two databases. There are probably cogent reasons why this is so but from a users point of view it means that PLANTS will contain a broad level of differing floristic and monographic, essentially region- or country-based, nomenclatural variations. Both these points must surely degrade the accuracy of the PLANTS database. These few observations suggest that some attention should be given to improving quality control in major databases.

8.5 Analysis of the conservation status of African Psoraleoid legumes

8.5.1 Results

106 species of Psoraleoid legumes occur in Africa south of the Sahara and are distributed among *Otholobium* (53 spp), *Psoralea* (49 spp.) and *Cullen* (4 spp). These have been assigned IUCN codes and are listed alphabetically by genus under each category (Table 8.6).

Table 8.6 Conservation status of African Psoraleeae, based on IUCN codes.

IUCN CONSERVATION CATEGORY	SPECIES NAME
Ex	Psoralea cataracta C.H. Stirton
	Psoralea guenzii Harv.
E	Cullen holubii Burtt Davy
	Otholobium carneum (E. Mey.) C.H. Stirton
	Otholobium dreweae C.H. Stirton
	Otholobium lanceolatum C.H. Stirton
	Otholobium pungens C.H. Stirton
	Otholobium saxosum C.H. Stirton
	Psoralea filifolia Eckl. & Zeyh.
	Psoralea glaucina Harv.
	Psoralea muirii C.H. Stirton
V	Otholobium argenteum (Thunb.) C.H. Stirton
	Otholobium bolusii (Forbes) C.H. Stirton
	Otholobium fruticans (L.) C.H. Stirton
	Otholobium incanum C.H. Stirton
	Otholobium rotundifolium (L.f.) C.H. Stirton
	Otholobium rubicundum C.H. Stirton

Table 8.6 Conservation status of African Psoraleeae, based on IUCN codes (continued).

IUCN CONSERVATION CATEGORY	SPECIES NAME
V	Otholobium sabulosum C.H. Stirton
	Otholobium thomii (Harv.) C.H. Stirton
	Otholobium venustum (Eckl. & Zeyh.) C.H. Stirton
	Otholobium zeyheri (Harv.) C.H. Stirton
	Psoralea arborea Sims
	Psoralea ensifolia (Houtt.) Merill
	Psoralea fleta C.H. Stirton
	Psoralea glaucescens Eckl. & Zeyh.
	Psoralea peratica C.H. Stirton
	Psoralea pullata C.H. Stirton
	Psoralea repens Berg.
	Psoralea rigidula C.H. Stirton
R	Otholobium bowieanum (Harv.) C.H. Stirton
	Otholobium flexuosum C.H. Stirton
	Otholobium hamatum (Harv.) C.H. Stirton
	Otholobium heterosepalum (Fourcade) C.H. Stirton
	Otholobium lucens C.H. Stirton
	Otholobium macradenium (Harv.) C.H. Stirton

Table 8.6 Conservation status of African Psoraleeae, based on IUCN codes (continued).

IUCN CONSERVATION CATEGORY	SPECIES NAME
R	Otholobium nitens C.H. Stirton
	Otholobium parviflorum (E.Mey.) C.H. Stirton
	Otholobium pictum C.H. Stirton
	Otholobium polyphyllum (Eckl. & Zeyh.) C.H. Stirton
	Otholobium pustulatum C.H. Stirton
	Otholobium racemosum (Thunb.) C.H. Stirton
	Otholobium spissum C.H. Stirton
	Otholobium swartbergense C.H. Stirton
	Psoralea abbottii C.H. Stirton
	Psoralea aculeata L.
	Psoralea azurea C.H. Stirton
	Psoralea crista C.H. Stirton
	Psoralea elegans C.H. Stirton
	Psoralea imbricata (L.f.) C.H. Stirton
	Psoralea imminens C.H. Stirton
	Psoralea implexa C.H. Stirton
	Psoralea intonsa C.H. Stirton
	Psoralea keetii Schonl. ex H.M.L. Forbes
	Psoralea laevigata L.f.

Table 8.6 Conservation status of African Psoraleeae, based on IUCN codes (continued).

IUCN CONSERVATION CATEGORY	SPECIES NAME
R	Psoralea nubicola C.H. Stirton
	Psoralea odoratissima Jacq.
	Psoralea oreophilá Schlechter
	Psoralea oreopola C.H. Stirton
	Psoralea restioides Eckl. & Zeyh.
	Psoralea trullata C.H. Stirton
	Psoralea triflora Thunb.
	Psoralea vlokii C.H. Stirton
K	Cullen biflora Harv.
	Psoralea fascicularis DC.
nt	Cullen obtusifolia DC.
	Cullen plicata Delile
	Otholobium accrescens C.H. Stirton
	Otholobium acuminatum (Lam.) C.H. Stirton
	Otholobium arborescens C.H. Stirton
	Otholobium bracteolatum (Eckl. & Zeyh.) C.H. Stirton
	Otholobium caffrum (Eckl. & Zeyh.) C.H. Stirton

Table 8.6 Conservation status of African Psoraleeae, based on IUCN codes (continued).

IUCN CONSERVATION CATEGORY	SPECIES NAME
nt	Otholobium candicans (Eckl. & Zeyh.) C.H. Stirton
	Otholobium foliosum (Oliv.) C.H. Stirton
	Otholobium fumeum C.H. Stirton
	Otholobium gazense (Baker) C.H. Stirton
	Otholobium hirtum (L.) C.H. Stirton
	Otholobium mundianum (Eckl. & Zeyh.) C.H. Stirton
	Otholobium nigricans C.H. Stirton
	Otholobium obliquum (E. Mey.) C.H. Stirton
	Otholobium polystictum (Benth. ex Harv.) C.H. Stirton
	Otholobium prodiens C.H. Stirton
	Otholobium sericeum (Poir.) C.H. Stirton
	Otholobium spicatum (L.) C.H. Stirton
	Otholobium stachyerum (Eckl. & Zeyh.) C.H. Stirton
	Otholobium striatum (Thunb.) C.H. Stirton
	Otholobium trianthum (E. Mey.) C.H. Stirton
	Otholobium uncinatum (Eckl. & Zeyh.) C.H. Stirton
	Otholobium virgatum (Burm. f) C.H. Stirton
	Otholobium wilmsii (Harms) C.H. Stirton
	Psoralea affinis Eckl. & Zeyh.

Table 8.6 Conservation status of African Psoraleeae, based on IUCN codes (continued).

IUCN CONSERVATION CATEGORY	SPECIES NAME
nt	Psoralea alata (Thunb.) Salter
	Psoralea aphylla L.
	Psoralea asarina (Berg.) Salter
	Psoralea axillaris L.f.
	Psoralea glabra E. Mey.
	Psoralea laxa Salter
	Psoralea monophylla (L.) C.H. Stirton
	Psoralea oligophylla Eckl. & Zeyh.
	Psoralea pinnata L.
	Psoralea plauta C.H. Stirton
	Psoralea rhizotoma C.H. Stirton
	Psoralea sordida C.H. Stirton
	Psoralea speciosa Eckl. & Zeyh.
	Psoralea tenuissima E. Mey.
	Psoralea verrucosa Willd.
	Total number of species of African Psoraleeae studied: 106

The genus *Cullen* comprises some 35 species (Stirton, 1981b) but is only sparsely represented in Africa (6% of the species). I have attributed IUCN codes to the African species only.

The data listed in Table 8.7 is based on nearly a decade of field, nursery and laboratory investigations. I have studied most of the taxa under a wide range of habitats in different stages of succession and seasonal development as well as biotic influences.

A few points need to be made about the data presented in Table 8.7:

(i) Columns 1-3 provide estimations of the size of local populations, the extent of geographical range in each taxon and of habitat specificity. Column 6 is a list of three letter codes which summarize the data in columns 1-3. The codes are first letter abbreviations of the slightly differently worded categories used by Karron (1987a) in his Fig. 1 (Fig. 8.1) and modified from Rabinowitz (1981).

A descriptive summary is given in Appendix 16 of the conservation status for each of the 106 African species of Psoraleeae . I have referred there and in various tables to a number of three letter codes. I have named these codes Rabinowitz codes as she initially proposed the categories on which they are based. Her Figure 1 may be translated as follows (the terms in brackets being those used by Karron, 1987a):

AWW - Locally abundant over a large range in several habitats (**Abundant, Widespread, Wide**).

AWN - Locally abundant over a large range in a specific habitat (**Abundant, Widespread, Narrow**).

ARW - Locally abundant in several habitats but restricted geographically (**Abundant, Restricted, Wide**).

ARN - Locally abundant in a specific habitat but restricted geographically (**Abundant, Restricted, Narrow**).

SWW - Constantly sparse over a large range and in several habitats (**Sparse, Widespread, Wide**).

SWN - Constantly sparse in a specific habitat but over a large range (**Sparse, Widespread Narrow**).

SRW - Constantly sparse and geographically restricted in a specific habitat (**Sparse, Restricted, Narrow**).

(ii) The codes used by Hall & Veldhuis (1985) differ slightly from those used by IUCN. I am grateful to Christine Leon who designed and provided me with a translation table (Table 8.5). I have used this to provide new category allocations for all the African Psoraleeae using both codes (Columns 4 & 5 of Table 8.7).

(iii) Columns 7-9 indicate those species which are heavy seeders, fire resistant and which have short (1-3 months), intermediate (4-5 months) or long (more than 6 months) flowering times. I have no data yet for flowering periods in *Psoralea* and *Cullen*.

Table 8.7 Conservation status of African psoraleoid legumes: correlation of Rabinowitz categories to seed production, fire tolerance and phenology.

SPECIES	LOCAL POPULATION SIZE	GEOGRAPHICAL RANGE	HABITAT SPECIFICITY	CONSERVATION CATEGORIES (Hall & Veldhuis 1985)	IUCN CATEGORY OF THREAT	RABINOWITZ CATEGORY	SEED PRODUCTION (* HEAVY SEEDERS)	FIRE TOLERANCE	DURATION OF FLOWERING (PHENOLOGY)
The genus Otholobium									
acuminatum	abundant	widespread	wide	nt	nt	AWW	*		S
accrescens	abundant	restricted	narrow	E	E	ARN			I
arborescens	sparse	widespread	narrow	nt	nt	SWN	*		I
argenteum	abundant	widespread	narrow	V	V	AWN		+	S
bolusii	sparse	widespread	narrow	V	V	SWN			I
bowieanum	abundant	restricted	narrow	R	R	ARN			S
bracteolatum	abundant	widespread	wide	nt	nt	AWW	*		L
caffrum	abundant	widespread	wide	nt	nt	AWW	*	+	L
candicans	sparse	widespread	wide	nt	nt	SWW			I
carneum	sparse	restricted	narrow	E	E	SRN		+	S
dreweae	abundant	restricted	narrow	V	V	ARN		+	I
flexuosum	sparse	restricted	narrow	R	R	SRN			S
foliosum	abundant	widespread	wide	nt	nt	AWW	*		L

Table 8.7 Conservation status of African psoraleoid legumes: correlation of Rabinowitz categories to seed production, fire tolerance and phenology.

SPECIES	LOCAL POPULATION SIZE	GEOGRAPHICAL RANGE	HABITAT SPECIFICITY	CONSERVATION CATEGORIES (Hall & Veldhuis 1985)	IUCN CATEGORY OF THREAT	RABINOWITZ CATEGORY	SEED PRODUCTION (* HEAVY SEEDERS)	FIRE TOLERANCE	DURATION OF FLOWERING (PHENOLOGY)
fruticans	abundant	restricted	narrow	V	V	ARN		+	S
fumeum	abundant	widespread	narrow	nt	nt	AWN			L
gazense	abundant	widespread	wide	nt	nt	AWW	*		L
hamatum	sparse	restricted	narrow	R	R	SRN	*		S
heterosepalum	sparse	restricted	narrow	R	R	SRN			S
hirtum	abundant	widespread	wide	nt	nt	AWW			S
incanum	sparse	restricted	narrow	V	V	SRN	*		S
lanceolatum	abundant	restricted	narrow	E	E	ARN		+	S
lucens	abundant	restricted	narrow	R	R	ARN		+	I
macradenium	abundant	restricted	narrow	R	R	ARN		+	S
mundianum	abundant	widespread	narrow	nt	nt	AWN			S
nigricans	abundant	widespread	wide	nt	nt	AWW	*		L
nitens	sparse	restricted	narrow	R	R	SRN	*	+	S

Table 8.7 Conservation status of African psoraleoid legumes: correlation of Rabinowitz categories to seed production, fire tolerance and phenology.

SPECIES	LOCAL POPULATION SIZE	GEOGRAPHICAL RANGE	HABITAT SPECIFICITY	CONSERVATION CATEGORIES (Hall & Veldhuis 1985)	IUCN CATEGORY OF THREAT	RABINOWITZ CATEGORY	SEED PRODUCTION (* HEAVY SEEDERS)	FIRE TOLERANCE	DURATION OF FLOWERING (PHENOLOGY)
obliquum	abundant	restricted	narrow	nt	nt	ARN			S
parviflorum	abundant	restricted	narrow	R	R	ARN		+	S
pictum	abundant	restricted	narrow	R	R	ARN		+	S
piliferum	sparse	restricted	narrow	V	V	SRN			S
polyphyllum	sparse	restricted	narrow	R	R	SRN	*	+	S
polystictum	abundant	widespread	wide	nt	nt	AWW			L
prodiens	abundant	widespread	wide	nt	nt	AWW			L
pungens	sparse	restricted	narrow	E	E	SRN			S
pustulatum	sparse	restricted	narrow	R	R	SRN	*		S
racemosum	abundant	restricted	narrow	R	R	ARN	*		S
rotundifolium	abundant	widespread	narrow	V	V	AWN		+	S
rubicundum	sparse	widespread	narrow	V	V	SWN		+	S
sabulosum	sparse	widespread	narrow	V	V	SWN			S

Table 8.7 Conservation status of African psoraleoid legumes: correlation of Rabinowitz categories to seed production, fire tolerance and phenology.

SPECIES	LOCAL POPULATION SIZE	GEOGRAPHICAL RANGE	HABITAT SPECIFICITY	CONSERVATION CATEGORIES (Hall & Veldhuis 1985)	IUCN CATEGORY OF THREAT	RABINOWITZ CATEGORY	SEED PRODUCTION (* HEAVY SEEDERS)	FIRE TOLERANCE	DURATION OF FLOWERING (PHENOLOGY)
saxosum	abundant	restricted	narrow	E	E	ARN			S
sericeum	abundant	widespread	wide	nt	nt	AWW	*		L
spicatum	abundant	widespread	narow	nt	nt	AWN	*		I
spissum	sparse	widespread	narrow	R	R	SWN		+	S
stachyerum	abundant	widespread	wide	nt	nt	AWW	*		L
striatum	sparse	widespread	wide	nt	nt	SWW			L
swartbergense	abundant	restricted	narrow	R	R	ARN			S
thomii	abundant	restricted	narrow	V	V	ARN			S
trianthum	sparse	widespread	wide	nt	nt	SWW			S
uncinatum	sparse	widespread	wide	nt	nt	SWW		+	S
venustum	sparse	widespread	narrow	V	V	SWW		+	S
virgatum	abundant	widespread	wide	nt	nt	AWW	*		L
wilmsii	abundant	widespread	wide	nt	nt	AWW	*		L

Table 8.7 Conservation status of African psoraleoid legumes: correlation of Rabinowitz categories to seed production, fire tolerance and phenology.

SPECIES	LOCAL POPULATION SIZE	GEOGRAPHICAL RANGE	HABITAT SPECIFICITY	CONSERVATION CATEGORIES (Hall & Veldhuis 1985)	IUCN CATEGORY OF THREAT	RABINOWITZ CATEGORY	SEED PRODUCTION (* HEAVY SEEDERS)	FIRE TOLERANCE	DURATION OF FLOWERING (PHENOLOGY)
zeyheri	abundant	widespread	narrow	V	V	AWN		+	
The genus Psoralea									
abbottii	sparse	widespread	narrow	R	R	SWN			
aculeata	sparse	widespread	narrow	R	R	SWN			
affinis	abundant	widespread	wide	nt	nt	AWW			
alata	sparse	widespread	narrow	nt	nt	SWN			
aphylla	abundant	widespread	narrow	nt	nt	AWN		+	
arborea	abundant	widespread	narrow	V	V	AWW			
asarina	sparse	widespread	narrow	nt	nt	SWN	*		
axillaris	abundant	widespread	wide	nt	nt	AWW	*	+	
azurea	sparse	restricted	narrow	R	R	SRN			

Table 8.7 Conservation status of African psoraleoid legumes: correlation of Rabinowitz categories to seed production, fire tolerance and phenology.

SPECIES	LOCAL POPULATION SIZE	GEOGRAPHICAL RANGE	HABITAT SPECIFICITY	CONSERVATION CATEGORIES (Hall & Veldhuis 1985)	IUCN CATEGORY OF THREAT	RABINOWITZ CATEGORY	SEED PRODUCTION (* HEAVY SEEDERS)	FIRE TOLERANCE	DURATION OF FLOWERING (PHENOLOGY)
cataracta	sparse	restricted	narrow		Ex	SRN			
crista	sparse	restricted	narrow	R	R	SRN			
elegans	sparse	restricted	narrow	R	R	SRN			
ensifolia	abundant	widespread	narrow	V	V	AWN		+	
fascicularis	abundant	restricted	narrow	U	K	ARN			
filifolia	abundant	widespread	narrow	E	E	AWN			
fleta	abundant	restricted	narrow	V	V	ARN	*		
glabra	abundant	widespread	wide	nt	nt	AWW			
glaucescens	abundant	widespread	narrow	V	V	AWN			
glaucina	sparse	restricted	narrow	E	E	SRN			
guenzii	abundant	restricted	narrow		Ex	ARN	*		
imbricata	abundant	widespread	narrow	R	R	AWN			
imminens	abundant	restricted	narrow	R	R	ARN		+	

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Table 8.7 Conservation status of African psoraleoid legumes: correlation of Rabinowitz categories to seed production, fire tolerance and phenology.

SPECIES	LOCAL POPULATION SIZE	GEOGRAPHICAL RANGE	HABITAT SPECIFICITY	CONSERVATION CATEGORIES (Hall & Veldhuis 1985)	IUCN CATEGORY OF THREAT	RABINOWITZ CATEGORY	SEED PRODUCTION (* HEAVY SEEDERS)	FIRE TOLERANCE	DURATION OF FLOWERING (PHENOLOGY)
implexa	sparse	restricted	narrow	R	R	SRN			
intonsa	abundant	restricted	narrow	R	R	ARN		+	
keetii	sparse	restricted	narrow	R	R	SRN			
laevigata	sparse	restricted	narrow	R	R	SRN			
laxa	abundant	widespread	wide	nt	nt	AWW			
monophylla	abundant	widespread	wide	nt	nt	AWW		+	
muirii	sparse	restricted	narrow	E	E	SRN		+	
nubicola	abundant	restricted	narrow	R	R	ARN			
odoratissima	sparse	restricted	narrow	R	R	SRN			
oligophylla	abundant	widespread	wide	nt	nt	AWW	*		
oreophila	sparse	restricted	narrow	R	R	SRN			
oreopola	abundant	widespread	narrow	R	R	AWN		+	
peratica	abundant	restricted	narrow	V	V	ARN			
pinnata	abundant	widespread	narrow	nt	nt	AWW	*		

Table 8.7 Conservation status of African psoraleoid legumes: correlation of Rabinowitz categories to seed production, fire tolerance and phenology.

SPECIES	LOCAL POPULATION SIZE	GEOGRAPHICAL RANGE	HABITAT SPECIFICITY	CONSERVATION CATEGORIES (Hall & Veldhuis 1985)	IUCN CATEGORY OF THREAT	RABINOWITZ CATEGORY	SEED PRODUCTION (* HEAVY SEEDERS)	FIRE TOLERANCE	DURATION OF FLOWERING (PHENOLOGY)
plauta	abundant	widespread	wide	nt	nt	AWW		+	
pullata	abundant	widespread	narrow	V	V	AWN	*		
repens	abundant	widespread	narrow	V	V	AWN			
restioides	abundant	widespread	narrow	R	R	AWN		+	
rhizotoma	abundant	widespread	narrow	nt	nt	AWN		+	
rigidula	abundant	restricted	narrow	V	V	ARN		+	
sordida	abundant	widespread	narrow	nt	nt	AWN			
speciosa	abundant	widespread	narrow	nt	nt	AWN			
tenuissima	sparse	widespread	narrow	nt	nt	SWN		+	
triflora	sparse	widespread	narrow	R	R	SWN			
trullata	sparse	widespread	narrow	R	R	SWN			
verrucoa	abundant	widespread	wide	nt	nt	AWW	*		
vlokii	abundant	restricted	narrow	V	V	ARN		+	

Table 8.7 Conservation status of African psoraleoid legumes: correlation of Rabinowitz categories to seed production, fire tolerance and phenology.

SPECIES	LOCAL POPULATION SIZE	GEOGRAPHICAL RANGE	HABITAT SPECIFICITY	CONSERVATION CATEGORIES (Hall & Veldhuis 1985)	IUCN CATEGORY OF THREAT	RABINOWITZ CATEGORY	SEED PRODUCTION (* HEAVY SEEDERS)	FIRE TOLERANCE	DURATION OF FLOWERING (PHENOLOGY)
The genus Cullen									
biflora	abundant	widespread	narrow	U	K	AWN			
holubii	sparse	restricted	narrow	E	E	SRN			
obtusifolia	abundant	widespread	wide	nt	nt	AWW	*		
plicata	abundant.	widespread	wide	nt	nt	AWW	*		

[1] N=narrow, M=medium, W=wide

8.5.2 **Conservation status of *Otholobium* and *Psoralea***

Table 8.8 is a statistical breakdown of the data presented in Table 8.7.

64% of all species are of immediate concern to conservationists (rare, extinct, endangered or vulnerable). This is immediately apparent from Fig. 8.2. At first glance the differences between *Psoralea* and *Otholobium* do not seem very striking. However, as I will point out in a later section *Psoralea* is significantly more threatened. It has much to do with this genus's tendency to occupy seepages, marshes and waterways whereas *Otholobium* is essentially a genus of drylands.

The assessment of endangered status using IUCN categories enables one to conclude that both genera are under considerable threat. But it does not inform about the nature of the threats, merely their degree. This is inevitable given the basis of the definitions of the categories which are nothing more than arbitrary points on a subjective continuum. What is needed therefore is some heuristic which will link the IUCN categories to the biology and environment of the plants. To achieve this I have had to approach the problem from a different perspective as will be shown in the next section.

8.5.3 **Application of Rabinowitz's typology of rarity to the African Psoraleeae**

This section makes use of the typology of rarity proposed by Rabinowitz (1981) described in section 8.5.1. and based on the data presented in Table 8.7.

Table 8.8 Statistical summary of the IUCN categories presented in Table 8.7 for the genera *Psoralea*, *Otholobium*, and *Cullen* in Africa.

CONSERVATION STATUS	CODE	*PSORALEA*	*OTHOLOBIUM*	*CULLEN*	TOTAL	%
Extinct	Ex	2 (4,1%)	0	0	2	1,9
Endangered	E	3 (6,1%)	5 (9,4%)	1	9	8,5
Vulnerable	V	9 (18,3%)	12 (22,6%)	0	21	19,6
Rare	R	18 (36,7%)	14 (25,4%)	0	32	30,2
Indeterminate	I	0	0	0	0	0
Insufficiently known	K	1	0	1	2	1,9
Not threatened	nt	16 (32,6%)	22 (41,5%)	2	40	37,7
Totals		49	53	4	106	

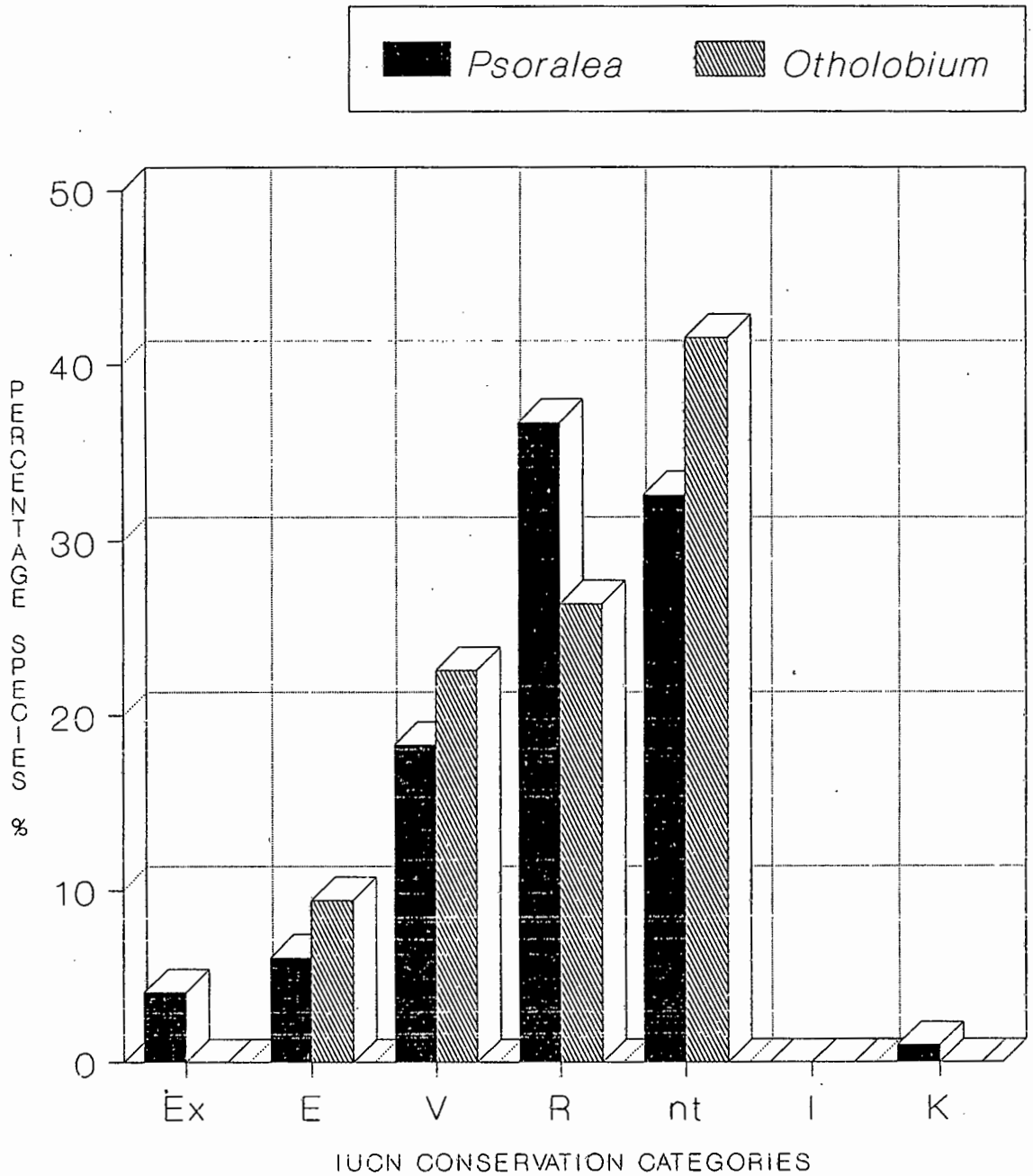


Fig. 8.2 Percentage occurrence of *Psoralea* and *Otholobium* in each IUCN conservation category.

I have viewed the data in two ways, both of which provide some useful insights. The first approach compares the number of species which occur in each of the elements which make up the categories (Table 8.9); the second approach is a comparative analysis of the distribution of species classified under each Rabinowitz category (Table 8.10).

8.5.3.1 **Distribution of taxa for each Rabinowitz element**

Table 8.9 is a summary of the number of species of the genera *Psoralea*, *Otholobium* and *Cullen* (pro parte) representative of each element of local population size, geographical range and habitat specificity.

The majority of species are locally abundant (>60%) and occupy fairly specific habitats (70%). Species of *Psoralea* tend to exhibit a narrower habitat specificity than those of *Otholobium*. This is in keeping with my estimation that 80% of *Psoralea* species grow in seepages, at the edges of vleis, streamsides and on high mountains which receive considerable amounts of daily mist whereas only 11% of *Otholobium* species occupy similar habitats.

8.5.3.2 **Distribution of taxa for each Rabinowitz category**

Table 8.10 is a summary of the number of species of the genera *Psoralea*, *Otholobium* and *Cullen* representative of each combined class of local population size, geographical range and habitat specificity.

Table 8.9 Summary of the number of species of the genera *Psoralea*, *Otholobium*, and *Cullen* in Africa distributed according to Local Population Size, Geographical Range and Habitat Specificity (Codes based on Rabinowitz (1981) and Karron (1987); see text for explanations).

CATEGORIES	CODE	*PSORALEA*	*OTHOLOBIUM*	*CULLEN* pro parte
A. LOCAL POPULATION SIZE				
Locally abundant	A	31 (63,3)	33 (63,3)	3
Constantly sparse	S	18 (36,7)	20 (37,7)	1
B. HABITAT SPECIFICITY				
Variable habitats	W	10 (20,4)	16 (30,2)	2
Specific habitats	N	39 (69,8)	37 (69,8)	2
C. GEOGRAPHICAL RANGE				
Wide ranging	W	29 (59,2)	30 (56,6)	3
Geographically restricted	W	20 (40,8)	20 (43,4)	1

Psoralea (49 spp.), *Otholobium* (53 spp.), and *Cullen* (4 spp. in Africa).

Table 8.10 Summary of the number of species of the genera *Psoralea*, *Otholobium*, and *Cullen* in Africa representative of each combined class of Local Population Size, Geographical Range and Habitat Specificity (Codes based on Rabinowitz (1981) and Karron (1987); see text for explanations. Percentages in brackets).

CODES	*PSORALEA*	*OTHOLOBIUM*	*CULLEN* *pro parte*	TOTAL PER CLASS
AWW	10 (20,4)	13 (24,5)	2	25
AWN	12 (24,5)	6 (11,3)	1	19
ARN	9 (18,4)	14 (26,4)	0	23
ARW	0	0	0	0
SWW	0	5	0	5
SWN	7	5	0	12
SRN	11 (22,5)	10 (18,7)	1	22
SRW	0	0	0	0
TOTALS (Number of species)	49	53	4	106

The different categories are more informative. The three largest categories in *Psoralea* (47%) are AWW, AWN and SRN; in *Otholobium* (70%) they are AWW, ARN and SRN. If all three genera are considered together then 75% of all the taxa fall into the three categories AWW, ARN, and SRN. None of the genera have taxa which are ARW or SRW and only 16% of the taxa are either SWW or SWN.

To understand what underlies these distributions I have coded, wherever known, each of the species for their fire susceptibility, seed producing capacity, phenological range, altitude and underlying geological substrate.

(i) *Seed producing capacity*

17 species of *Otholobium* and 9 species of *Psoralea* produce large seed crops each year. 72% of these species are characterized as AWW plants. A number of the species have become widely distributed along recently built roadsides and in areas of disturbance: *O. bracteolatum*, *O. gazense*, *O. hirtum*, *O. nigricans*, *O. sericeum*, *O. spicatum*, *O. stachyerum* and to a lesser extent *P. glabra*, *P. pinnata* and *P. verrucosa*. *O. parviflorum* is the only heavy seeding species which is not extending its range.

There are a number of species in which seed set is either very occasional or absent and in which reproduction appears to be partially or wholly rhizomatous: *O. lanceolatum*, *O. dreweae*, *O. thomii*, *O. rotundifolium* and *O. accrescens*. These are ARN and AWN plants. It is perhaps significant that all of these plants have extensive root systems and large woody rootstocks. These are quite typical of what Williams (1975) refers to as "**Resprouters**". I have never encountered seedlings of these species in the wild.

Some of the resprouters are very rare. *O. lanceolatum* (ARN) appears to number about 45 individual plants (over an areas of 2 hectares) which judging from the short gnarled thickened stems and branches must be very old.

Despite a number of searches I know of only one colony of *O. accrescens* (ARN). This rhizomatous species covers an area of some 1000 m^2, but it is difficult to judge how many plants actually comprise the population. Flowering in this species is very rare according to the local Forester. The species does regenerate shoot growth annually.

The rhizomatous species *O. dreweae* (ARN) is known from two very small colonies and may in fact only comprise two individuals.

(ii) *Fire susceptibility*

38% and 30% of *Otholobium* and *Psoralea* species are fire resistant, but none of the *Cullen*. Of these only *P. ensifolia* occurs in seepage areas; all the other species grow on drier slopes. Only 17% of the heavy seeding Otholobiums are fire-resistant: *O. caffrum*, *O. parviflorum* and *O.wilmsii*. In contrast all heavy seeding Psoraleas are fire-susceptible and grow in or near damp areas. In these species, after fires, there is a massive production of seedlings, especially in those species which are the dominant shrubs or small trees of their habitats. Root nodule production of these species is considerably greater than seedlings from drier areas. The majority of seedlings die within two years.

60% of the fire-resistant Otholobiums are ARN plants, but examples exist for each Rabinowitz category. Perhaps of more interest is that 90% of all taxa occupy specific habitats. In *Psoralea* AWN species form the largest group. Half of the fire-resistant species are abundant locally and widespread in distribution compared to 40% in *Otholobium*.

(iii) *Flowering phenology*

As my studies of *Psoralea* are still incomplete I am able to give accurate flowering phenological data for *Otholobium* only (Tables 8.11 & 8.12). I have divided the phenological data into three classes: **short** (1-3 months), **intermediate** (4-5 months) and **long** (more than 6 months).

59% of species in the genus have short flowering periods. All of the SRN species flower within two months whereas 80% of the AWW species have, discounting clinal effects, long flowering periods. The seasonal course of flowering in the genus *Otholobium* is shown in Fig. 8.3.

Kruger (1981) recently reviewed seasonal growth and flowering rhythms in South African heathlands and concluded that the few published data preclude an integrated account of periodicity in fynbos. The data for *Otholobium* (Fig. 8.3) does however conform to the general pattern shown in his Fig. 1.2 (Kruger, 1981; unfortunately he does not provide a graded X-axis so an accurate comparison is impossible). The periodicity of shoot extension, which precedes flowering, was discussed in 2.2.2.1.1.

Table 8.11 The distribution of three phenological classes (short, 1-3 months; intermediate, 4-5 months; long, 6 or more months) in 50 species of *Otholobium* grouped under each Rabinowitz (1981) category. Accurate information is not available for all the species.

RABINOWITZ CATEGORY	SHORT 1-3 months	INTERMEDIATE 4-5 months	LONG 6-12 months
AWW	2	0	10
AWN	2	2	1
ARN	10	2	1
SWW	3	1	1
SRN	11	0	0
SWN	3	2	0
TOTAL	31	7	12

Table 8.12 Phenological patterns in the genus *Otholobium* (CR, Critically rare; E, Endangered; V, Vulnerable; NE, not endangered). For details on the Rabinowitz codes see the text.

			1 J	2 F	3 M	4 A	5 M	6 J	7 J	8 A	9 S	10 O	11 N	12 D
acuminatum	CR	AWN												
accrescens	E	ARN												
arborescens	NE	SWN												
bolusii	V	SWN												
bowieanum	CR	ARN												
bracteolatum	NE	AWW												
caffrum	NE	AWW												
candicans	NE	SWW												
carneum	E	SRN												
flexuosum	CR	SRN												
foliosum	NE	AWW												
fruticans	V	ARN												
fumeum	NE	AWN												
gazense	NE	AWW												
hamatum	CR	SRN												
heterosepalum	CR	SRN												
hirtum	NE	AWW												
incanum	V	SRN												
lanceolatum	E	ARN												
lucens	CR	ARN												
macradenium	CR	ARN												
mundianum	NE	AWN												
nigricans	NE	AWW												
nitens	CR	SRN												
obliquum	NE	ARN												
parviflorum	CR	ARN												
pictum	CR	ARN												
piliferum	V	SRN												
polyphyllum	CR	SRN												
polystictum	NE	AWW												
prodiens	NE	AWW												
pungens	E	SRN												
pustulatum	NE	SRN												
racemosum	CR	ARN												
rotundifolium	CR	ARN												
rubicundum	CR	SRN												
sabulosum	CR	SRN												
saxosum	CR	ARN												
sericeum	NE	AWW												
spicatum	NE	AWW												
spissum	CR	SRN												
stachyerum	NE	AWW												
striatum	NE	SWW												
swartbergense	CE	ARN												
thomii	CR	ARN												
trianthum	NE	SRN												
uncinatum	NE	SRN												
venustum	CR	SRN												
wilmsii	NE	AWW												
zeyheri	CR	ARN												

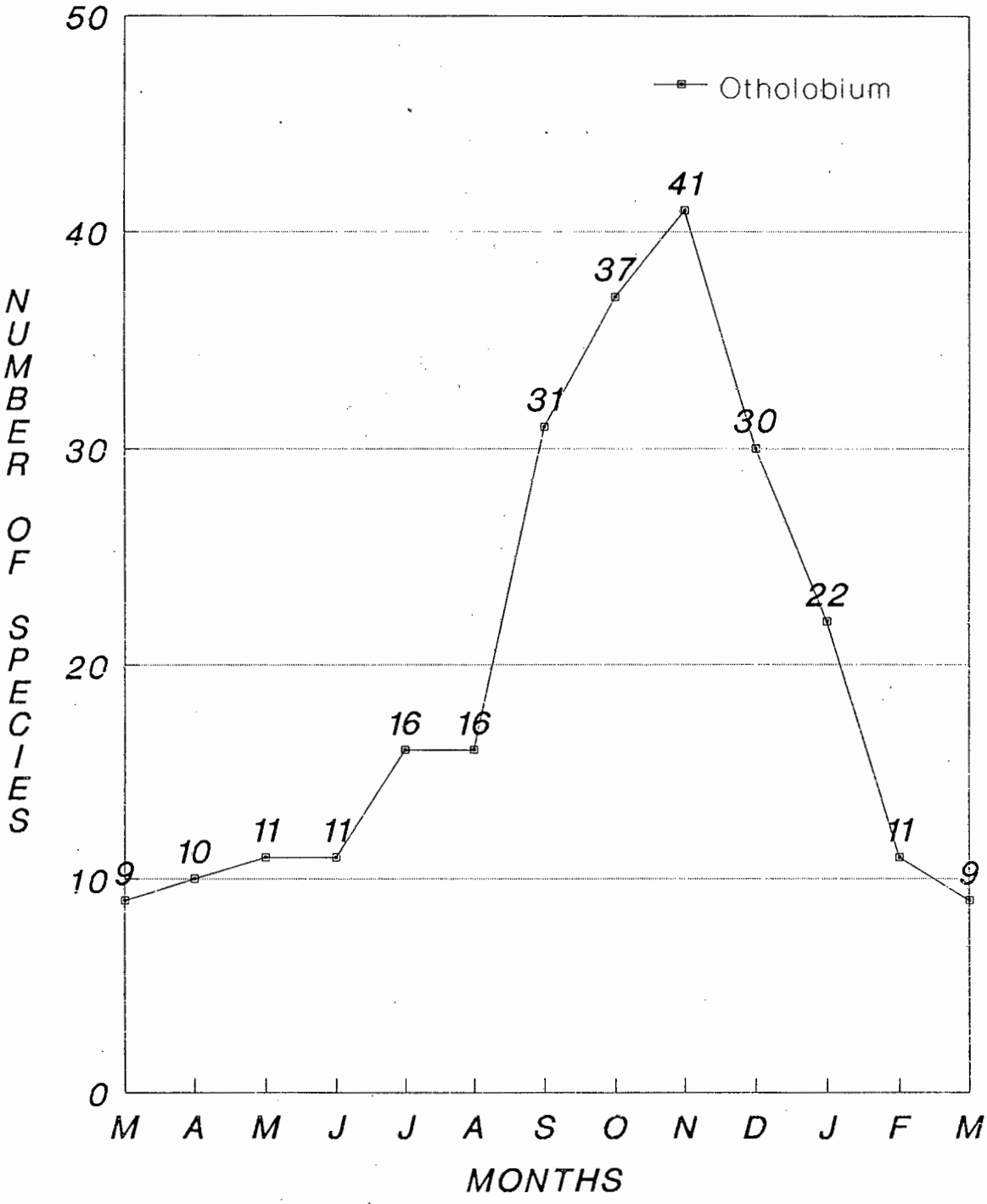


Fig. 8.3 Flowering cycle in *Otholobium*.

Table 8.13 The number and types of pedological series in 42 species of *Otholobium* grouped under each Rabinowitz (1981) category. Accurate information is not available for all the species.

RABINOWITZ CATEGORY	C1	C2	N	V	K1	K3	K4	AG7	AG9	U	TOTALS
AWW	2	1	6								9
AWN	4										5
ARN	8	2	2				1				12
SWW			2	1					1		4
SRN		1	1	2							4
SWN	5					1		1		1	8
TOTALS	19	3	6	9	0	1	1	1	1	1	42

C1 = Quartzite, shale, tillite (Table Mountian Sandstone Series); C2 = shale, sandstone (Bokkeveld Series); N = Quartzite, arkose, limestone, shale, phyllite, tillite, lava, tuff (Nama System); K1 = Tillite, sandstone, shale (Dwyka series); K3 = shale, mudstone, sandstone, limestone, coal (Beaufort Series); K4 = Sandstone, shale, mudstone, marl (Stormberg Series); AG7 = Migmatite, gneiss, ultrmetamorphic rocks (Namaqualand and Natal belts of metamorphization and granitization); AG9 = Granite, syenitic rocks, quartz porphyry; U = Unconsolidated superficial deposits, conglomerate, limestone, sandstone, marl; V = 2 or more of the above groups.

(iv) *Basic geology*

The distributions of 42 species of *Otholobium* were superimposed on the Geological Survey Map of South Africa (1970, Geological Survey, Government Printer, Pretoria). Table 8.13 lists the different geological groups falling within each Rabinowitz category. Group V refers to species with distributions that ranged across two or more geological groups.

45% of the species are distributed on the Table Mountain Sandstone Series; 42% of these species are ARN plants. AWW plants are mainly distributed across two or more geological groups.

(v) *Altitude*

Table 8.14 shows the altitudinal range for each species of *Otholobium*. These ranges are divided into three class intervals for comparison against the six Rabinowitz categories which apply to *Otholobium*.

From Table 8.15 it seems that the AWW and AWN species are distributed across a wider altitudinal range whereas the remaining categories, especially ARN and SRN species, have very narrow altitudinal ranges. 47% of all species, regardless of categories, occur within a narrow altitudinal band.

Table 8.15 reveals other interesting data. 18 species (34%) range above 1000m. Only three species occur entirely above 1500m: *O. foliosum*, *O. gazense* and *O. swartbergense* whereas four species occur below 300m.

Table 8.14 Altitudinal patterns in the genus *Otholobium*. For details on the Rabinowitz codes see the text.

Otholobium		Altitude (metres)
		300 600 900 1200 1500 1800 2100 2400
acrescens	ARN	550-650
accuminatum	AWW	275 500
arborescens	SWN	250 500
argenteum	AWN	900 1200
bolusii	SWN	150 1000
bracteolatum	AWW	3 400
bowieanum	ARN	500-650
caffrum	AWW	1000 2200
candicans	SWW	120 600
carneum	SRN	1200/1400
dreweae	ARN	200-250
foliosum	AWW	1500 3500
flexuosum	SRN	650 850
fumeum	AWN	1200 2400
gazense	AWW	1000 2500
hamatum	AWW	1000 1600
heterosepalum	SRN	350-600
hirtum	AWW	20 650
incanum	SRN	80/120
lanceolatum	ARN	600-650
lucens	ARN	600-650
macradenium	ARN	1100-1500
mundianum	AWN	1000 1500
nigricans	AWW	1500 2100
nitens	SRN	700 1200
obliquum	ARN	500 1100
parviflorum	ARN	250-350
pictum	ARN	650 1300
piliferum	SRN	
polyphyllum	SRN	400-600
prodiens	AWW	250 600
pungens	SRN	400-500
pustulatum	SRN	700-800
racemosum	ARN	900-1000
rotundifolium	AWN	130 540
rubicundum	SWN	600-1000
sabulosum	SWN	60-200
saxosum	ARN	600
sericeum	AWW	200 600
spicatum	AWN	30 500
spissum	SWW	300-600
stachyerum	AWW	200 2000
striatum	SWW	300 1100
swartbergense	ARN	1500-1700
thomii	ARN	300-600
trianthum	SWW	200 700
uncinatum	SWW	0 300
venustum	SWW	40-60
virgatum		0 350
wilmsii	AWW	250 800
zeyheri	AWN	600-900

Table 8.15 The distribution of three altitudinal classes (narrow, 0-300m; intermediate, 301-600m; broad, above 600m) in 50 species of *Otholobium* grouped under each Rabinowitz (1981) category. Accurate information is not available for all the species.

RABINOWITZ CATEGORY	NARROW 0-300m	INTERMEDIATE 301-600M	BROAD >600	TOTALS
AWW	2	5	5	12
AWN	1	4	2	7
ARN	9	2	1	12
SWW	2	2	1	5
SRN	3	1	1	5
SWN	8	1	0	9
TOTALS	25	15	10	50

8.6 Biotic and anthropogenic threats to the survival of African Psoraleeae

The global nature of plant extinctions have elicited considerable concern in recent years (Koopowitz & Kaye, 1983 for a popular account). As Raven (1987) has pointed out some 7500 plants may already be extinct, with a rapid decline in tropical species worldwide. The nature of this threat has been summarised in the very useful book **Plants in Danger: What do we know?** (Davis *et. al*, 1986). This publication treats each country separately and is also a valuable resource of conservation literature in South Africa. The status of the conservation of plants in southern Africa is given by Hall, de Winter, Fourie and Arnold (1984).

In this section I propose to look at some of the biotic and anthropogenic forces which are at play in influencing the long term survivability of Psoraleeae in Africa. I will conclude the chapter with a short discussion on the practical implications and will indicate how plant systematists may contribute to plant conservation.

8.6.1 Biotic and anthropogenic threats

It is often difficult to separate the influences of some natural and anthropogenic factors in causing decline or fluxes in natural populations. Sometimes there is an alternation of both forces, for example, a combination of a short period of naturally and man-induced burns. I will illustrate this with an example from *Psoralea*.

There is a fluctuating population of *Psoralea* species which occurs below Shaw's Pass, Hermanus side, which produces spontaneous hybrids. The parental species are *Psoralea arborea* and *P. aphylla*. The plants grow in a 40 m wide by 100 m strip of seepage and are the dominant shrubs and treelets. This particular patch has been burned twice since I began observing it; one burn was natural, the other man-induced.

The dynamics of these two species and their hybrids are very instructive for conservationists. When I first visited the locality in 1981 there were very few individuals of either *P. aborea* (*Stirton 9959*) or the hybrid (*Stirton 9948*). The stand was dominated by *P. aphylla* (*Stirton 9949*). A fire intervened before my next visit in January, 1986. On this occasion *P. arborea* (*Stirton 11124*) was dominant with a few *P. aphylla* (*Stirton 11125*). By November the large number of juvenile plants that I had noticed the previous January, and which I had been unable to identify, had matured into clearly identifiable hybrids (*Stirton 11123*) and a few scattered *P. aphylla*.

This pattern of parent and hybrid density fluxes occurs in other areas where these two species are sympatric and hybridize. Unfortunately, the combination of overburning with overgrazing in the surrounding area, reducing the quantity of water which feeds the seepage, combined with extensive trampling within the stands, particularly after the most recent burn, is drastically reducing the population. I doubt whether it and many like it in this area will survive.

Fires are vital for the long term survival of these two seed regenerating species but if the burns are too frequent they will kill the parent plants and by stimulating massive germination of the seedbank will reduce it without replenishment. If this were to be combined with the trampling of grazing animals there will be severe damage to the seedling population and few plants will survive to maturity. Fortunately for these two

species and their natural hybrids they are abundant and well-protected in a number of inaccessible populations in Forestry and Nature Reserves so their long term survival seems assured.

Hall and Veldhuis (1985) list a number of main threats affecting threatened plants in the coastal plains and foothills from Somerset West to Elim in South Africa. They correctly stress the importance of causal links among the disturbing factors. Accepting that in some cases more than one factor may be involved and using their study as a guideline with a presentation idea from Sukopp and Trautmann (1981) I have drawn up a table of causal factors and the species of Psoraleeae which are most threatened by them (Table 8.16). A graphic illustration of this data is given in Fig. 8.6. Agricultural activity, exotic plant invasions, and urban-industrial development account for 70% of the threat to African psoraleoid Leguminosae. As some species may be affected by more than one factor the sum of species indicated on the figure is greater than the total number of species.

8.7. Biology of Extinction

The proximal and ultimate causes of extinction in plants and animals have been much researched and discussed in recent years (Schafer, 1981; Frankel & Soulé, 1981).

A good example of a proximate cause is Mertz's (1971) study on the mathematical demography of the California Condor populations; an example of a failure of recruitment to offset mortality. Terborgh and Winter (1980) provide a table of major primary and secondary ultimate causes.

Table 8.16 Species of Psoralea and Otholobium which are threatened by the biotic and environmental factors listed in Fig. 8.6.

1. **Agriculture**

O. bolusii
O. candicans
O. incanum
O. lanceolatum
O. pungens
O. rubicundum
P. filifolia
P. muirii
P. peratica

2. **Plant invaders**

O. bracteolatum
O. fumeum
O. fruticans
O. racemosum
O. rotundifolium
P. aculeata
P. azurea
P. vlokii

3. **Urban-industrial development**

O. bolusii
P. alata
P. arborea
P. glaucina
P. guenzii

4. **Land drainage and dam building**

P. aphylla
P. arborea
P. ensifolia
P. filifolia

5. **Too frequent burning**

P. arborea
P. accrescens

6. **Flower-picking**

O. acuminatum

7. **Plantation development**

O. heterosepalum

8. **Road-building and earthworks**

P. fleta

9. **Overgrazing and trampling**

P. abbottii

10. **Dune destruction and vehicular disturbance**

P. repens

FACTORS INFLUENCING EXTINCTION IN THE GENUS *OTHOLOBIUM*

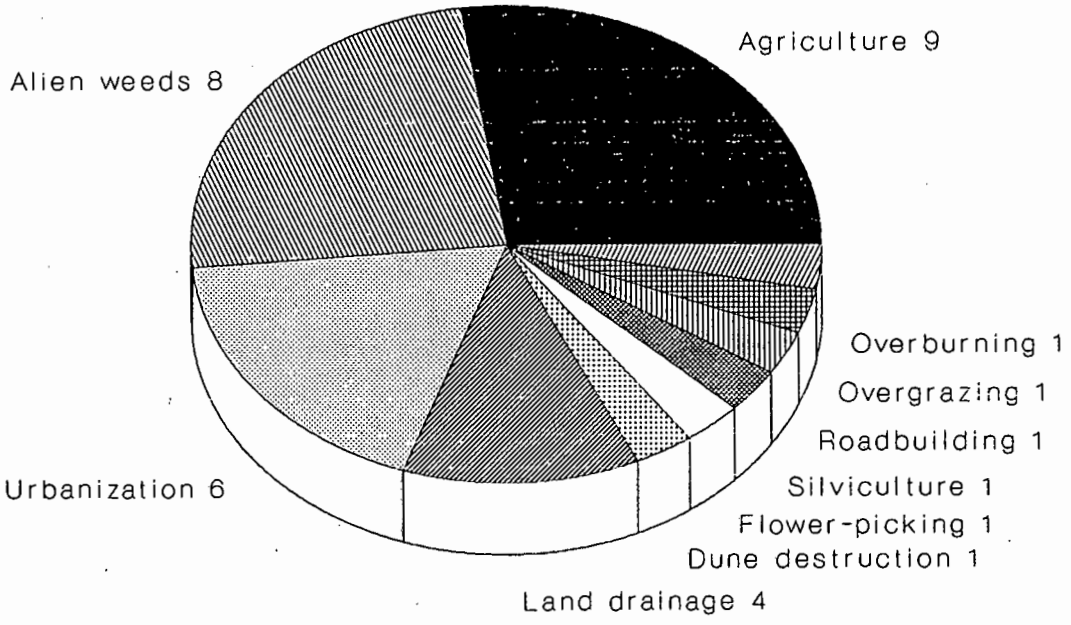


Fig. 8.6 Causes of the decline of plant species, arranged by decreasing numbers of species involved.

Recently interest has begun to focus on the nature of the natural decline in organisms (Soulé & Wilcox, 1980) and its modification by non-natural causal factors, but as was pointed out earlier there may be many causal links among the disturbing factors which threaten plants. It is these synergistic interactions (Myers, 1987), difficult to unravel, that should be of critical concern to conservationists and which deserve urgent study. Over the years I have observed many of these interactions, partly as a result of a holistic, multifunctional-structural or constraints approach to biology (Polhill, Raven & Stirton, 1981; Schrire, 1989) and partly as witnessing some remarkably dynamic changes in populations of naturalised weeds over as short a period as a decade. A number of examples will be discussed below.

My interest in the dynamics and nature of conservation biology stems from work on hybridization studies of *Eriosema* (Stirton, 1981c); the agamic *Lantana camara* L. weed complex in southern Africa (Stirton 1977, 1978, 1979; Spies & Stirton 1982) and finally on inter-subgeneric hybrid swarms in the eastern Transvaal (Spies, Stirton & Du Plessis, 1987). During the course of these studies I became aware of the many biotic and abiotic factors which were apparently influencing the degree of manifestation, direction of spread, fluctuating size of populations, and impact on the surrounding plant communities being invaded.

It has been a shock to see with what rapidity the invasive apomictic weed *Chromolaena odorata* (L.) King & Robinson has ousted *L. camara* in Natal from its previously dominant position in many plant communities. *C. odorata* also swamps undisturbed vegetation, including those free of *L. camara* infestations. This, coupled with the extensive building of holiday resorts along the southern Natal coastal grasslands, especially between Port Shepstone and Port Edward, and the extension of sugarcane plantations, has resulted in such a degradation of these species rich grasslands that

their demise must rank with that of the coastal fynbos of the south-western Cape. The scientific importance of these subtropical coastal grasslands is that they are the ecotone between the Cape Flora and the Tropical Floras. I would estimate that the majority of these "mixed" areas are now destroyed or in severe decline. A typical indicator species in seepage areas is *Psoralea paludosa* Stirton sp. nov. ined., once widespread from the Transkei to Durban, based on old herbarium records, is now surviving only in a few undisturbed coastal seepages. The cessation of fires is a major destroyer of species diversity in these grasslands.

I mention the above examples to highlight some of the difficulties facing those responsible for the management of endangered species. So much of South Africa is now irretrievably fragmented and disrupted that much of the debate about and consensus on the estimation of minimum viable population size (MVP) is rather meaningless for large areas of the country where the chances of establishing new "maximum size" reserves predicted by theory is no longer an option. Clearly some new approaches will be needed to deal with areas as has been mentioned above.

One idea which I propose is that managers should establish the frequency of the different Rabinowitz codes within their areas and then assess their management priorities according to which of the codes they favour. A dominance of AWW species will obviously require different management to a dominance of SRN species.

As a systematist who monitors the diversity, interaction and density of vegetation rather the mere pattern I find it difficult to understand much of the simplistic stochastic modelling much in vogue in the literature. As Harris and Maguire (1987) point out most simulation models estimate the probability of extinction based on

demographic and environmental variability but neglect to incorporate catastrophic variability. Other difficulties arise from neglecting to account for the sampling errors associated with stochastic simulations and not running enough replications.

The distrust which many managers have with such simulations may stem from some of the pitfalls alluded to. However, there is clearly a future for improved algorithms provided the basic data is gathered carefully within a sound theoretical framework. Such a framework appears to be provided by the burgeoning field of Conservation Biology which has as its task the establishing of principles and tools for the preservation of biological diversity. For a detailed and informative position on the functional (mechanistic) and ethical (normative) postulates see Soulé (1985).

The sort of difficulties that face biologists running stochastic simulations can be seen in the study by Huston and Smith (1987) on the interaction of life history and competition in plant succession. Their model has important implications for conservationists. They argue that:

> *"the classical successional patterns of species replacement results from a particular structure of correlations among life history and physiological characteristics and that atypical patterns of succession result when this correlation is altered".*

They then contend:

> *"that primary and secondary succession can be modelled as non-equilibrium processes, capable of interacting with disturbances to produce steady-state communities whose properties depend on abiotic conditions, such as temperature and resource levels, and on the type and frequency of disturbances".*

As to one of the major implications of this model it is concluded that the structure of correlations among life history and physiological traits constrains the successional patterns commonly found in nature to a small subset of the possible patterns.

I was struck by a recent review of Pianka (1985) of the book **Evolutionary Ecology** by Shorrocks (1984) in which he contrasts the essentially non-evolutionary ecological time-scale of British ecology (especially ecological genetics) with the broader evolutionary approach which dominates American ecology. He refers to the virtual lack of cross-references of the two spheres to each other and ends with *"It is most heartening to see this awakening in Great Britain and the tacit recognition of some American ecologists"*.

Leaving aside that Pianka's perspective ignores the rest of ecology being practiced elsewhere in the world his comments are brought into sharp focus by a very readable and candid appraisal of evolutionary biology, sharpened by having worked under both paradigms. In his astute analysis of the influence of the evolutionary synthesis on New and Old World evolutionary studies he concludes that the time is right for an *Evolutionary Dys-synthesis*. What he is really saying is that there is about a climate of "*conflict, controversies and new discoveries .... that is infusing evolutionary biology with vigour and excitement*".

I agree with this analysis. I believe that there is a revival of experimentation, a demand for quantification accompanied by the development of exact methods of phylogeny construction. As Pianka stresses:

"Evolutionary science has for too long been a muddled simplistic science willing to stay at the periphery of its own concepts. When evolutionary processes are seen as mechanistic events with precise causes and effects, when questions are posited as clear hypotheses amenable to empirical test, then and only then will we be able to trap Darwin's Unicorn and truly demonstrate that there are indeed many bottles for much good wine"

I am in broad agreement with the new mood (Stirton 1987, Stirton & Zarucchi, 1989). The **New Biology** is very much part of the basic approach adopted by Conservation Biologists. The scientific status of modern evolutionary theory is undergoing intense scrutiny (Riddiford & Penny, 1985; Cohen, 1985) and an insight into some of these topics can be found in Pollard (1985).

The influence and impact of new studies on the fluidity of plant genomes, of estimating plant phylogenetic relationships and of understanding microevolutionary processes is beginning to have a major impact on evolutionary research (Clegg, 1987; Palmer, 1985; Doyle, 1987; Temin & Engels, 1985; Culiis, 1985; Steele, Goryczynski & Pollard, 1985).

8.8 **Conclusions**

What can we conclude from this combination of dramatic advances in evolutionary theory side by side with the rapidly increasing discontinuum of disturbed and often stable non-equilibrium systems that have become the remit of conservation biologists everywhere?

Plant systematists, especially molecular systematists, have a crucial role in the years ahead, not only to expand and maintain the floristic inventory, but also to collect critical morphological data as well as new types of data such as that presented in this chapter. This will provide crucial information for molecular systematics (using proteins, amino acids, RNA's and DNA's).

There is trend at present whereby molecular systematics is being seen by administrators in the U.S.A. and Europe as being the only area of systematics which requires support - A cruel and meaningless development from a Third World perspective. However, there is indeed a grave danger that molecular systematics will shortly be overloaded with too many graduates chasing too few jobs in northern countries and that their current major contribution to the Third World inventory, where the diversity is, will tail off to the severe detriment of poorer countries. These and other points concerning recent trends in systematics are put into their proper perspective by Bremer (1988), Mishler, Bremer, Humphries and Churchill (1988), and Crowe (1988). Mishler *et. al.* (1988) also point out that molecular systematists should pay close attention to the large body of theory developed primarily by morphological phylogeneticists.

Crowe (1988) suggests that the:

> "*.... so-called molecules vs morphology 'controversy' currently plaguing phylogenetic systematics is ... an artefact of flawed philosophy, improper project design and incorrect methods of data analysis, and that the controversy is sustained primarily by conflict of personalities.*"

I agree with most of these points and with his conclusion that the controversy may be best resolved simply by a closer collaboration between morphologists and molecular biologists. He wittily projects that morphological systematists may one day, faced by a barrage of DNA-DNA hybridization trees, end up as collection managers whose primary function will be to resort museum collections into the new phylogenetic order. Personally I doubt whether there is even the remotest chance of this. Molecular systematists would be incapable of screening the thousands of new species coming out of Amazonia each year, yet alone knowing whether they were new to start with! Such a task would be minor in comparison to replacing the thousands of detailed systematic monographs currently being researched. Debates such as the molecular vs. morphology one seem to be grounded in unrealism. The antagonists seem to forget that someone has to describe the species to begin with. Clearly Crowe's (1988) quotation at the end of his paper, from the avian biologist Raikow (1981: 412), is appropriate:

> *"The heart of the matter is the need for rigorous character analysis ... and an amiable consideration of other viewpoints".*

Conservation biology is going to be an important development of the nineties as I believe it will go some way towards building bridges between reductionist and lateralist biologists. This chapter has been part of that process and shows that field-oriented systematists still have a vital role in the new order of things.

REFERENCES

Acocks, J.P.H. 1975. *Veld Types of South Africa.* Mem. Bot. Survey South Africa No 40. Government Printer, Pretoria.

Adamson, R.S. 1948. Some geographical aspects of the Cape Flora. *Trans. Roy. Soc. S. Afr.* 31: 437-464.

Adamson, R.S. 1958. The Cape as an ancient flora. *Pres. Address, sect. K. (Bot.), Adv. Sci.* 15: 118-127.

Adamson, R.S. 1960. The phytogeography of Molluginaceae with reference to southern Africa. *Jl. S. A. Bot.* 26,1: 17-35.

Adamson, R.S. and Salter, T.M. 1950. *Flora of the Cape Peninsula.* Juta, Cape Town.

Adamus, P.R. and Clough, G.C. 1978. Evaluating species for protection in natural areas. *Biol. Conserv.* 13,3: 165-178.

Agrawal, J.S. and Tayyab, M.A. 1958. Chromosome number in *Psoralea corylifolia* L. *Sci. & Cult.* 23: 652-653.

Allen, O.N. and Allen, E.K. 1981. *The Leguminosae: A sourcebook of characteristics, uses and nodulation.* University of Wisconson Press, Madison.

Alway, F.J. and Pickney, R.M. 1909. On the relation of native legumes to the soil nitrogen of Nebraska Prairies. *J. Ind. Eng. Chem.* 1: 771-772.

Anderberg, A. 1986. The genus *Pegolettia* (Compositae, Inuleae). *Cladistics* 2,2: 158-186.

Appleman, M.D. and Sears, O.H. 1943. Further evidence of interchangeability among the groups of *Rhizobium leguminosarum*. *Soil Sci. Soc. Amer. Proc.* 7: 363-264.

Arnot, S. 1984. A study of variation in *Bituminaria bituminosa*. M.Sc. thesis, Reading University, Reading.

Avise, J.C. 1974. Systematic value of electrophoretic data. *Syst. Zool.* 23: 465-481.

Ax, P. 1984. *The Phylogenetic System: The Systematization of Organisms on the Basis of their Phylogenies.* John Wiley & Sons, Chichester.

Axelrod, D.I. and Raven, P.H. 1978. Late Cretaceous and Tertiary vegetation history of Africa. In M.J.A. Werger (Editor), *Biogeography and Ecology of Southern Africa, 1.* pp. 77-130. Junk, Den Haag.

Ayensu, E.S. 1981. Assessment of threatened plant species in the United States. In H. Synge (Editor), *The Biological Aspects of Rare Plant Conservation*. pp. 19-58. Wiley-Interscience, Chichester.

Bakale, V.L. and Sharma, S.S. 1982. Mitosis and karyotype of *Psoralea corylifolia* L. *J. Ind. bot. Soc.* 61: 263-267.

Baker, E.G. 1911. A contribution to our knowledge of the plants of Gazaland. *Linn. Soc. J. Bot.* 40: 16-76.

Baker, H.A. and Oliver, E.G.H. 1967. *Ericas in Southern Africa.* Purnell, Cape Town.

Baquar, R.S. & Husain, S.A. 1967. Chromosome studies in some flowering plants of West Pakistan. I. *Phyton* 24: 49-55.

Barneby, R.C. 1977. Daleae Imagines. *Mem. N. Y. Bot. Gard.* 27: 1-892.

Barneby, R.C. 1981. Amorpheae. In R.M. Polhill and P.H. Raven (Editors), *Advances in Legume Systematics, Part 1.* pp. 344-346. Royal Botanic Gardens, Kew.

Baskin, J.M. and Caudle, C. 1966. In IOPB plant chromosome reports. VIII. *Taxon* 15: 279-284.

Baskin, J.M. and Baskin, C.C. 1985. Photosynthetic pathway in 14 southeastern glade endemics, as revealed by leaf anatomy. *Amer. Midl. Nat.* 114: 205-208.

Baskin, J.R. & Quarterman, E. 1970. Autoecological studies of *Psoralea subacaulis*. *Amer. Midl. Nat.* 84,2: 376-397.

Baudet, J.C. 1974. Signification taxonomique des caractères blastogeniques dans la tribu des Papilionaceae-Phaseoleae. *Bull. Jard. Bot. Nat. Belg.* 44: 259-293.

Beadle, N.C.W. 1964. Nitrogen economy in arid and semi-arid plant communities. Part 3. The symbiotic nitrogen fixing organisms. *Proc. Linn. Soc. N.S.W.* 89,2: 273-286.

Beatty, I. 1982. Classes and cladists. *Syst. Zool.* 31: 25-34.

Bennett, E.L. and Bonner, J. 1953. Isolation of plant growth inhibitors from *Thamnosma montana*. *Amer. J. Bot.* 40: 29-33.

Bennett, M.D. 1983. The genome, the natural karyotype, and biosystematics. In W.F. Grant (Editor), *Plant Biosystematics*. Academic Press, Toronto

Bennett, M.D. and Smith, J.B. 1976. Nuclear DNA amounts in Angiosperms. *Phil. Trans. Roy. Soc. Lond.(B.)* 274: 227-274.

Bentham, G. 1865. Leguminosae. In G. Bentham and J.D. Hooker (Editors), *Genera Plantarum*. 1,2: 434-600. Lovell Reeve, London.

Bertoloni, A. 1839. *Horti Botanici Bononiensis Plantae Novae vel Minus Cognitae*. Bologna.

Bews, J.W. 1921. *An Introduction to the Flora of Natal and Zululand.* City Printing Works, Pietermaritzburg.

Björkman, O. 1973. Comparative studies on photosynthesis in higher plants. *Photophysiology* 8: 1-63.

Black, C.C. 1973. Ecological implications of dividing plants into groups with distinct photosynthetic production capacities. *Adv. Ecol. Res.* 7: 87-114.

Blackmore, S. 1984. Pollen features and plant systematics. In V.H. Heywood & D.M. Moore (Editors), *Current Concepts in Plant Taxonomy*. pp. 135-154. Academic Press, London.

Boardley, M., Stirton, C.H. and Harborne, J.B. 1986. A chemotaxonomic survey of the tribe Psoraleeae in Africa. *Biochem. Syst. Evol.* 14,6: 603-613.

Bolley, H.L. 1893. Notes on root tubercles (Wurzelknollchen) of indigenous and exotic legumes in virgin soil of Northwest. *Agric. Sci.* 7: 58-66.

Bond, P. and Goldblatt, P. 1984. *Plants of the Cape Flora*. J. S. Afr. Bot., Suppl. Vol 14: 1-455.

Boulter, D. 1981. Proteins of legumes. In R.M. Polhill and P.H. Raven (Editors), *Advances in Legumes Systematics, Part 2.* pp. 501-512. Royal Botanic Gardens, Kew.

Boverstock, P.R., Cole, S.R., Richardson, B.J. and Watts, C.H.S. 1979. Electrophoresis and cladistics. *Syst. Zool.* 28: 214-219.

Bowen, G.D. 1956. Nodulation of legumes indigenous to Queensland. *Queensl. J. Agric. Sci.* 13: 47-60.

Brady, E.R., Wemple, D.K. and Lersten, N.R. 1964. Floral vasculature as a potential taxonomic character in *Dalea* (Leguminosae). *Proc. Iowa Acad. Sci.* 71: 46-51.

Bratton, S.P. and White, P.S. 1981. Rare plant management - after preservation what? *Rhodora* 82: 49-75.

Bremer, K. 1985. [Review of] Scala Milletiearum: a survey of the genera of the tribe Millettieae (Legum.-Pap.) with methodological considerations. *Cladistics* 1: 393-396.

Bremer, K. 1988. The limits of amino acid sequencing in angiosperm phylogenetic reconstruction. *Evolution* 42,4: 795-803.

Brenan, J.P.M. 1978. Some aspects of the phytogeography of tropical Africa. *Ann. Missouri Bot. Gard.* 65: 437-478.

Brooks, D.R. and Wiley, E.O. 1985. Theories and methods in different approaches to phylogenetic systematics. *Cladistics* 1,1: 1-12.

Brown, A.H.D. 1979. Enzyme polymorphism in plant populations. *Theotetical Pop. Biol.* 15: 1-42.

Brundin, L. 1972. Phylogenetics and Biogeography. *Syst. Zool.* 21: 69-79.

Brundin, L. 1981. Croizat's panbiogeography versus phylogenetic biogeography. In G. Nelson and D.E. Rosen (Editors), *Vicariance Bigeography*. pp. 94-138. Columbia University Press, New York.

Burbidge, N.T. 1960. The phytogeography of the Australian region. *Austr. J. Bot.* 8: 75-211.

Burtt Davy, J. 1932. *A Manual of the Flowering Plants and Ferns of the Transvaal and Swaziland, Part 2.* London.

Candolle, A.P de. 1825. *Mèmoires sur la Famille L'egumineuses.* 515 pp. Paris.

Cappelletti, E.M., Innocenti, G. and Caporale, G. 1984. Furocoumarin localization in the fruit and seed of *Psoralea corylifolia* L. *Plantes Med. Phytherap.* 18: 181-190.

Carlquist, S.J. 1975. Wood anatomy and relationships of the Geissolomotaceae. *Bull. Torr. Bot. Club* 102: 128-134.

Carlquist, S.J. 1977. Wood anatomy of Grubbiaceae. *Jl. S. Afr. Bot.* 43: 129-144.

Carlquist, S.J. 1978. Wood anatomy of Bruniaceae: Correlations with ecology, phylogeny, and organography. *Aliso* 9: 323-364.

Carlquist, S.J. and DeBuhr, L. 1977. Wood anatomy of Penaeaceae (Myrtales): Comparative, phylogenetic, and ecological implications. *Bot. J. Linn. Soc.* 75: 211-227.

Cartmill, M. 1981. Hypothesis testing and phylogenetic reconstruction. *Z. zool. Syst. Evolut.-forsch.* 19: 73-96.

Chapman, J.D. and White, F. 1970. *The Evergreen Forests of Malawi*. Commonwealth Forestry Institute, Oxford.

Clegg, M.T. (Editor). 1987. *Plant Molecular Evolution*. Supplement of *Amer. Nat.* 130: S1-S100.

Clegg, M.T. 1987. Evolution of higher plant chloroplast DNA-encoded genes: implications for structure function and phylogenetic studies. *Ann. Rev. Plant Physiol.* 38: 391-418.

Cohen, I.B. 1985. *Revolution in Science*. Bellknap Press, Cambridge (Massachusetts).

Colless, D.H. 1984. The Wagner Olympics; short is beautiful. *Austr. Syst. Bot. Soc. Newsl.* 40:10-15.

Compton, R.H. 1912. An investigation of the seedling structure of the Leguminosae. *J. Linn. Soc. Bot.* 41: 1-122.

Corby, H.D.L. 1974. Systematic implications of nodulation among Rhodesian legumes. *Kirkia* 9,2: 301-329.

Corby, H.D.L. 1980. *Rhizobial root nodules in the classification of the Leguminosae*. Ph.D dissertation, University of Rhodesia.

Corby, H.D.L. 1981. The systematic value of root leguminous nodules. In R.M. Polhill and P.H. Raven (Editors), *Advances in Legumes Systematics, Part 2.* pp. 657-670. Royal Botanic Gardens, Kew.

Corby, H.D.L., Polhill, R.M. and Sprent, J.I. 1983. Taxonomy. In W.J. Broughton (Editor), *Nitrogen Fixation. Volume 3: Legumes.* Oxford Science Publications, Oxford.

Couderc, H. 1979. Etude des stades de jeunesse chez plusiers especeis du genre *Anthyllis*. *Bull. Soc. Bot. Fr.* 126, Actual bot. 3: 93-98.

Courtenay-Latimer, M., Smith, G.G., Bokelmann, H. and Batten, A. 1967. *The Flowering Plants of the Tsitsikama Forest and Coastal National Park*. National Parks Board of South Africa, Pretoria.

Cracraft, J. 1979. Phylogenetic analysis, evolutionary models and palaeontology. In J. Cracraft and N. Eldredge (Editors), *Phylogenetic Analysis and Paleontology.* pp. 7-39. Columbia University Press, New York.

Cracraft, J. and Eldredge, N. (Editors). 1979. *Phylogenetic Analysis and Paleontology.* Columbia University Press, New York.

Crisp, M.D. 1982. Evolution and biogeography of *Leptosema* (Leguminosae: Papilionoideae). In W.R. Barker and P.J.M. Greenslade (Editors), *Evolution of the Flora and Flora of Arid Australia*. pp. 317-322.

Crisp, M.D. and Weston, P.H. 1987. Cladistics and legume systematics, with an analysis of the Bossiaeeae, Brongniartieae and Mirbelieae. In C.H. Stirton (Editor), *Advances in Legume Systematics, Part 3.* pp. 65-130. Royal Botanic Gardens, Kew.

Cronquist, A. 1968. *The Evolution and Classification of Plants.* Nelson. London.

Cronquist, A. 1987. A botanical critique of cladism. *Bot. Rev.* 53: 1-52.

Crowe, T.M. 1988. Molecules vs. morphology in phylogenetics: A non-controversy. *Trans. Roy. Soc. S. Afr.* 46,4: 317-334.

Csapody, V. 1968. *Keimlingsbestimmungsbuch der Dikotyledonen*. 186 pp. Akademia Kiado, Budapest.

Cullis, C.A. 1985. Environmentally induced DNA changes. In J.F. Pollard (Editor), *Evolutionary Theory: paths into the future*. pp. 203-216. John Wiley & Sons, Chichester.

Dahlgren, R. 1963. Studies on *Aspalathus*: phytogeographical aspects. *Bot. Notiser* 116: 431-472.

Dahlgren, R. 1968. Distribution and substrate in the South African genus *Aspalathus* L. Leguminosae. *Bot. Notiser* 121: 505-534.

Dahlgren, R. and Rasmussen, F.N. 1983. Monocotyledon evolution: characters and phylogenetic estimation. In M.K. Hecht, B. Wallace and G.T. Prance (Editor), *Evolutionary Biology, Volume 16.* pp. 255-395. Plenum, New York.

Dallwitz, M.J. 1974. A flexible program for generating identification keys. *Syst. Zool.* 23: 53-57.

Dallwitz, M.J. 1980. A general guide for coding taxonomic descriptions. *Taxon* 29: 41-46.

Dallwitz, M.J. and Paine, T.A. 1986. *User's Guide to the DELTA System: A General System for Processing Taxonomic Descriptions.* Division of Entomology Report No. 13. CSIRO, Canberra.

Darnley Gibbs, 1974. *Chemotaxonomy of Flowering Plants*. McGill-Queens University Press, Montreal.

Datta, P.C. and Maiti, R.K. 1968. Cytotaxonomy of a few species of the tribe Galegeae (Papilionaceae). *Genet. Iberica* 20: 161-177.

Davis, S.D., Droop, S., Gregerson, P., Henson, L., Leon, C., Lamlein Villa-Lobos, J., Synge, H. and Zantovska, J. 1986. *Plants in Danger: What do we know.* IUCN, Gland.

Dawson, M. 1900. Further observations on the nature and functions of the nodules of leguminous plants. *Phil. Trans., Ser. B*, 193: 51-67.

Deacon H.J. 1979. Palaeoecology. In J. Day, W.R. Siegfried, G.N. Louw, and M.L. Jarman (Editors), *Fynbos Ecology, A preliminary Synthesis*. pp. 58-69. S. A. Nat. Sci. Progr. Report No. 40.

De Bary, A. 1877. *Vergleichende Anatomie der Vegetationsorgane der Phanerogamen und Farne.* Engelmann, Leipzig.

De Candolle, A.P. 1825. *Prodromus Systematis Naturalis Regnis Vegetabilis*. Vol. 2. Paris.

De Jong, R. 1980. Some tools for evolutionary and phylogentic studies. *Z. zool. syst. Evol.-forsch.* 18: 1-23.

Dell, B. and McComb, A.J. 1978. Plant resins - their formation, secretion and possible functions. In W.H. Woolhouse (Editor), *Advances in Botanical Research, Vol. 6.* pp. 277-316. Academic Press, London.

Denys, E. 1980. A tentative phytogeographical division of tropical Africa based on a mathematical analysis of distribution maps. *Bull. Jard. bot. nat. Belg.* 50: 465-504.

De Vogel, E.F. 1979. *Seedlings of Dicotyledons.* PUDOC, Wageningen.

Di Fulvio, T.E. 1971. Complemento cromosomico diploide de *Psoralea higuerilla* (Leguminosae). *Kurtziana* 6: 297-298.

Doliner, L.H. and Joliffe, P.A. 1979. Ecological evidence concerning the adaptive significance of the C_4 dicarboxylic acid pathway of photosynthesis. *Oecologia* 38: 23-34.

Don, G. 1830. Leguminosae. In J.C. Loudon (Editor), *Hortus Brittanicus*. Longman, London.

Doyle, J.J. 1987. Variation at the DNA level: Uses and potential in Legume systematics. In C.H. Stirton (Editor), *Advances in Legume Systematics, Part 3.* pp. 1-30. Royal Botanic Gardens, Kew.

Drury, W.H. 1980. Rare species of plants. *Rhodora* 82: 3-48.

Duke, J.A. 1965. Keys for the identification of seedlings of some prominent woody species in eight forest types in Puerto Rico. *Ann. Missouri. Bot. Gard.* 52: 314-350.

Duke, J.A. 1969. On tropical tree seedlings; seeds, seedlings, systems and systematics. *Ann. Missouri. Bot. Gard.* 56: 125-161.

Duke, J.A. and Polhill, R.M. 1981. Seedlings of Leguminosae. In R.M. Polhill and P.H. Raven (Editors), *Advances in Legume Systematics, Part 2.* pp. 941-949. Royal Botanic Gardens, Kew.

Duncan, T. and Stuessy, T.F. 1984. *Cladistics: Perspectives on the Reconstruction of Evolutionary History.* Columbia University Press, New York.

Dupuis, C. 1978. Permanence et actualitè de la systematique: la 'systematique phylogènetique' de W. Hennig (Historique, discussion, choix de rèferences). *Cahiers des Naturalistes* 34: 1-69.

Dyer, R.A. 1966. Impressions on the subject of the age and origin of the Cape flora. *S. A. J. Sci.* 62: 187-190.

Ecklon, C.F. and Zeyher, C. 1836. *Enumeratio Plantarum Africae Australis*. Hamburg.

Edwards, D. and Jessop, J.P. 1967. Proposed replacement of magisterial districts by a latitude-longitude system for plant distribution by the Botanical Research Institute. *S. Afr. Forum Botanicum* 5: 1-5.

Edwards, D. and Leistner, O.A. 1971. A degree reference system for citing biological records in southern Africa. *Mitt. bot. St. Samml., Münch.* 10: 501-509.

Eldredge, N. and Cracraft, J. 1981. *Phylogenetic Pattern and the Evolutionary Process.* Columbia University Press, New York.

El-Gazzar, A. 1981. Systematic implications of susceptibility to *Uromyces* rusts in Leguminosae. In R.M. Polhill & P.H. Raven (Editors), *Advances in Legume Systematics, Part 1.* pp. 979-994. Royal Botanic Gardens, Kew.

Engler, A. 1882. *Versuch einer Entwicklungsgeschichte der Pflanzenwelt, insbesondere der Florengebeite seit der Teriarperiode*. Vol. 2. Engelmann, Leipzig.

Erdtman, G. (1952). *Pollen Morphology and Plant Taxonomy: Angiosperms*. E.J. Brill, Leiden.

Eriksson, J. 1873. Studier ofver Leguminosernas rotknolar. *Acta Univ. Lund.* 10,8: 1-30.

Fahn, A. 1979. *Secretory Tissues in Plants*. Academic Press, London.

Fahn, A. 1985. *Plant Anatomy*. 3rd Edition. Pergamon Press, Oxford.

Farris, J.S. 1970.Methods for computing wagner trees. *Syst. Zool.* 19: 83- 92.

Farris, J.S. 1985. The pattern of cladistics. *Cladistics* 1,2: 190-201.

Farris, J.S., Kluge, A.G. and Eckhardt, M.J. 1970. A numerical approach to phylogenetic systematics. *Syst. Zool.* 19: 172-189.

Felsenstein, J. 1982. Numerical methods for inferring evolutionary trees. *Quart. Rev. Biology* 57: 379-404.

Ferguson, I.K. 1984. Pollen morphology and biosystematics of the subfamily (Papilionoideae). In W.F. Grant (Editor), *Plant Biosystematics*. pp. 377-394. Academic Press, Toronto.

Ferguson, I.K., Furness, C. and Stirton, C.H. 1989. Pollen morphology of the tribe Psoraleeae. In preparation.

Ferguson, I.K. and Skvarla, J.J. 1981. The pollen of the subfamily Papilionoideae (Leguminosae). In R.M. Polhill & P.H. Raven (Editors), *Advances in Legume Systematics, Part 1.* pp. 859-896. Royal Botanic Gardens, Kew.

Ferguson, I.K. and Skvarla, J.J. 1983. The granular instititium in the pollen of subfamily Papilionoideae (Leguminosae). *Amer. J. Bot.* 70: 1401-1408.

Fernandes, A. and Queiros, M. 1978. Contribution à la connaisance cytotaxonomique des Spermatophyta du Portugal. IV. Leguminosae (Suppl. 3). *Bol. Soc. Brot.* 52: 79-164.

Fink, W.L. 1986. Microcomputers and phylogenetic analysis. *Science* 234: 1135-1139.

Forbes, H.M.L. 1930. The genus *Psoralea* Linn. *Bothalia* 3: 116-136.

Frankel, O.H. and Soulé, M.E. 1981. *Conservation and Evolution*. Cambridge University Press, Cambridge.

Funk, V.A and Stuessey, T.F. 1978. Cladistics for the practicing taxonomist. *Syst. Bot* 3: 159-178.

Gaffney, E.S. 1979. An introduction to the logic of phylogeny construction. In J. Cracraft and N. Eldredge (Editors), *Phylogenetic Analysis and Paleontology*. pp. 79-111. Columbia University Press, New York.

Geesink, R. 1984. Scala Millettiearum. *Leiden Botanical Series* 8: 1-131.

Gibbs Russell, G.E. 1985. PRECIS: the National Herbarium's computerised information system. *S. A. J. Sci.* 81: 62-65.

Gilbert, G. and Lèonard, J. 1954. Importance des plantules pour la dèlimitation des genres. *8e Congrés Int. Bot. Paris, Rapp. et Comm. sect.* 2-6: 49-50.

Goldblatt, P. 1978. An analysis of the flora of southern Africa: its characteristics, relationships and origins. *Ann. Missouri Bot. Gard.* 64: 243-295.

Goldblatt, P. 1981. Cytology and the phylogeny of the Leguminosae. In R.M. Polhill and P.H. Raven (Editors), *Advances in Legumes Systematics, Part 2.* pp. 427-464. Royal Botanic Gardens, Kew.

Goldblatt, P. 1981. Chromosome numbers in Legumes. II. *Ann. Missouri Bot. Gard.* 68: 551-557.

Good, R. 1974. *The Geography of the Flowering Plants.* 4th Edition. Longmans, London.

Good, R.B. and Lavarack, P.S. 1981. The status of Australian plants at risk. In H. Synge (Editor), *The Biological Aspects of Rare Plant Conservation.* pp. 81-91. Wiley-Interscience, Chichester.

Gottlieb, L.D. 1981. Electrophoretic evidence and plant populations. *Progress Phytochem.*7: 1-46.

Grant, W.S. and Robinson, E.R. 1989. *Protein Electrophoresis in Population Genetics and Systematics.* Wits University Press, Johannesburg (In Preparation).

Greilhuber, J. 1984. Chromosomal evidence in taxonomy. In V.H. Heywood and D.M. Moore (Editors), *Current Concepts in Plant Taxonomy.* pp. 157-180. Academic Press, London & Orlando.

Greuter, W. and Raus, T. 1986. Med-Checklist notulae. *Willdenowia* 16: 103-109.

Grimes, J.W. 1986. A reevaluation of the discontinuity plate in Psoraleeae and Amorpheae (Leguminosae). *Amer. J. Bot.* 73,8: 1222-1229.

Grimes, J.W. 1988. Lectotypifications of infrageneric taxa in Psoraleeae (Leguminosae: Papilionoideae). *Brittonia* 40,3: 296-297.

Grobbelaar, N. and Clark, B. 1972. A qualitative study of the nodulating ability of legume species: List 2. *S. Afr. J. Bot.* 38,4: 241-247.

Grobbelaar, N., Beijma, C.M. van and Todd, C.M. 1967. A qualitative study of the nodulating ability of legume species: List 1. *Publ. Univ. Pretoria* n.s. 38. 9pp.

Guillaumin, A. 1910.L'étude des germinations appliquée a la classification des genreset a la phylogenie des groupes. *Rev. Gèn. Bot.* 22: 449-468.

Haccius, B. 1940. Untersuchungen über die Bedeutung der Distichie dur des Verstendnis der Zeistreuten Blatt Stellung bei den Dikotylen. *Bot. Archiv.* 40: 58-150.

Hall, A.V., de Winter, B., Fourie, S.P. and Arnold, T.H. 1984. Threatened plants in southern Africa. *Biol. Conserv.* 28: 5-20.

Hall, A.V., de Winter, M., de Winter, B. and van Oosterhout, S.A.M. 1980. *Threatened Plants of southern Africa.* South African National Scientific Programmes Report No. 45.

Hall, A.V. and Veldhuis, H.A. 1985. *South African Red Data Book: Plants - Fynbos and Karoo Biomes.* South African National Scientific Programmes Report No. 117.

Halstead, L.B. 1982. Evolutionary trends and the phylogeny of the Agnatha. In K.A. Joysey and A.E. Friday (Editors), *Problems of Phylogenetic Reconstruction*. pp. 159-196. Academic Press, London & New York.

Hamrick, J.L. 1983. The distribution of genetic variation within and among natural plant populations. In C.M. Schonewald-Cox, S.M. Chambers, B. MacBryde and W.L. Thomas (Editors), *Genetics and Conservation: a reference for managing wild animals and plant populations*, pp. 335-348. Benjamin Cummings, Menlo Park.

Hamrick, J.L., Linhart, Y.B. and Mitton, J.B. 1979. Relationships between life history characteristics and electrophoretically detectable genetic variation in plants. *Ann. Rev. Ecol. Syst.* 10: 173-200.

Harms, H. 1899. Beitrage zur flora von Afrika. *Bot. Jahrb.* 26: 286.

Harper, J.L. 1981. The meanings of rarity. In H. Synge (Editor), *The Biological Aspects of Rare Plant Conservation*. pp. 189-303. Wiley-Interscience, Chichester.

Harris, R.B. and Maguire, L.A. 1987. Sample sizes for minimum viable population estimation. *Biological Conservation* 1,1: 72-76.

Harvey, W.H. 1862. Leguminosae. In W.H. Harvey and O.W. Sonder (Editors), *Flora Capensis*. Vol. 2. Reeve, London.

Hedberg, O.1963. Afroalpine Flora elements. *Webbia* 19: 519-529.

Hedge, V. and Tilak, V.D. 1981. Anatomy of the seedling in the Leguminosae. 2. *Ind. J. Bot.* 4,2: 96-102.

Hemsley, A.J. and Ferguson, I.K. 1985. Pollen morphology of the genus *Erythrina* (Leguminosae: Papilionoideae) in relation to floral structure and pollinators. *Ann. Missouri Bot. Gard.* 72: 570-590.

Hendy, M.D. and Penny, D. 1982. Branch and bound algoritms to determine minimal evolutionary trees. *Mathematical Biosciences* 59; 277- 290.

Hennig, W. 1950. *Grundzüge einer Theorie der phylogenetischen Systematik.* Deutscher Zentralverlag.

Hennig, W. 1966. *Phylogenetic Systematics*. University of Illinois Press, Urbana, Chicago, London.

Heusser, C.J. 1971. *Pollen & Spores of Chile*. University of Arizona Press, Tuscon.

Hickey, L.J. 1979. A revised classification of the architecture of dicotyledonous leaves. In C.R. Metcalfe and L. Chalk (Editors), *Anatomy of the Dicotyledons*. pp. 25-39. Oxford University Press, Oxford.

Hildebrand, F. 1866. Ueber eine eigenthumliche Form von Milchsaftbehaltern. *Flora* 6: 81-85.

Hill, C.R. and Camus, J.M. 1982. Pattern cladists or evolutionary cladistics? *Cladistics* 2,4: 362-375.

Hilliard, O.M. 1978. The geographical distribution of compositae native to Natal. *Notes R. bot. Gard. Edinb.* 36: 407-425.

Hilliard, O.M. and Burtt, B.L. 1987. *The Botany of the Southern Natal Drakensberg*. Annals of the Kirstenbosch Botanical Garden, No 15.

Hiltis, D.M. 1987. Molecular versus morphological approaches to systematics. *Ann. Rev. Ecol. Syst.* 18: 23-42.

Holmgren, P.K., Keuken, W. and Schofield, E.R. 1981. *Index Herbariorum* Junk, The Hague and Boston.

Hull, D. 1979. The limits of cladism. *Syst. Zool.* 28: 416-440.

Humphries, C.J. and Chappill, J.A. 1988. Systematics as science: A response to Cronquist. *Bot. Rev.* 54,2: 130-144.

Humphries, C.J. and Funk, V. 1984. Cladistic methodology. In V.H. Heywood and D.M. Moore (Editors), *Current Concepts in Plant Taxonomy*. pp. 323-362. Academic Press, London.

Huston, M. and Smith, T. 1987. Plant succession: Life history and competition. *Amer. Nat.* 130,2: 168-198.

Hutchinson, J. 1964. *The Genera of Flowering plants*. Oxford University Press, Oxford.

Ingham, J. 1977. Phytoalexins of hyacinth bean (*Lablab niger*). *Z. Naturforsch.* 32c: 1018.

Ingham, J. 1983. Naturally occurring isoflavonoids (1855-1981). *Progr. Chem. Org. Nat. Prod.* 43: 1-266.

Innocenti, G. Cappelletti, E.M. and Caporale, G. 1984. Morphological and chemical characteristics of some Australian *Psoralea* species. *Int. J. Crude Drug. Res.* 22: 97-109.

Iseley, D. and Polhill, R.M. 1980. Leguminosae subfamily Papilionoideae. *Taxon* 29: 105-119.

James, S. 1984. Lignotubers and burls - Their structure, function and ecological significance in Mediterranean ecosystems. *Bot. Rev.* 50,3: 225-266.

Janvier, P. 1984. Cladistics: Theory, purpose, and evolutionary implications. In J.W. Pollard (Editor), *Evolutionary Theory: Paths into the Future*. pp. 39-75. John Wiley, Chichester.

Jenkins, R.E. 1975. Endangered plant species: a soluble ecological problem. *Nature Conserv. News* 25: 20-21.

Karschon, R. 1971. Lignotuber occurrence in *Eucalyptus camaldulensis* Dehn. and its phylogenetic significance. *Flora* 160: 495-510.

Karron, J.D. 1987a. The pollination ecology of co-occurring geographically restricted and widespread species of *Astragalus* (Fabaceae). *Biol. Conserv.* 39: 179-193.

Karron, J.D. 1987b. A comparison of levels of genetic polymorphism and self-compatibility in geographically restricted and widespread plant congeners. *Evol. Ecol.* 1: 47-58.

Kavanaugh, D.H. 1972. Hennig's principles and methods of phylogenetic systematics. *The Biologist* 54: 115-127.

Keeley, J.E. 1977. Seed Production, seed populations in soil, and seedling production after fire for two congeneric pairs of sprouting and non-sprouting chaparral shrubs. *Ecology* 58: 820-829.

Keighery, G.J. 1978. Chromosome numbers in Western Australian plants. I. *J. Roy. Soc. W. Austr.* 60: 105-106.

Kerr, L.R. 1925. The lignotubers of Eucalypt seedlings. *Proc. Royal Soc. Victoria* 37: 79-97.

Killick, D.J.B. 1978. The afro-alpine region. In M.J.A. Werger (Editor), *Biogeography and Ecology of Southern Africa*. pp. 515-560. Junk, Den Haag.

Kiriakoff, S.G. 1960. Filosofische grondslagen van de biologische systematiek. *Naturuuw. Tijdschr.* 42:35-57.

Klucking, E.P. 1986. *Leaf Venation Patterns. Vol. 1. Annonaceae.* Cramer, Berlin & Stuttgart.

Koningsveld, H. 1982. *Het Verschijnsel Wetenschap.* Boom Meppel, Amstersdam.

Koopowitz, H. and Kaye, H. 1983. *Plant Extinction: A Global Crisis*. Stonewall, Washington.

Kreuter, E. 1929. Chromosomenstudien bei den Galegeen. *Ber. Deutsh. Bot. Gesell.* 47,2: 99-101.

Kreuter, E. 1930. Beitrag zu karyologish-systematiscen Studien an Galegeen. *Planta* 11,1: 1-44.

Kruckeberg, A.R. and Rabinowitz, D. 1985. Biological aspects of endemism in higher plants. *Ann. Rev. Ecol. & Syst.* 16: 447-479.

Kruger, F.J. 1979. South African Heathlands. In R.L. Specht (Editor), *Heathlands and Related Shrublands. 9A.* pp. 19-80. Elsevier Scientific Publishing, New York.

Kruger, F.J. 1981. Seasonal growth and flowering rhythms: South African heathlands. In R.L. Specht (Editor), *Heathlands and Related Shrublands. 9B.* pp. 1-4. Elsevier Scientific Publishing, New York.

Kubitzki, K. 1984. Phytochemistry in plant systematics and evolution. In V.H. Heywood & D.M. Moore (Editors), *Current Concepts in Plant Taxonomy*. pp. 263-277. Academic press, London.

Kupicha, F.K. 1977. The delimitation of the tribe Vicieae (Leguminosae) and the relationships of *Cicer* L. *Bot. J. Linn. Soc.* 74: 131-162.

Lackey, J.A. 1978. Leaflet anatomy of the Phaseoleae (Leguminosae: Papilionoideae) and its relation to taxonomy. *Bot. Gaz.* 139: 436-446.

Ladiges, P.Y., Humphries, C.J. and Brooker, M.I.H. 1983. Cladistic relationships and biogeographic patterns in the pepermint group of eucalypts. *Austr. J. Bot.* 31: 565-584.

Lang, J.M. 1972. *Eysenhardtia* (Leguminosae): Taxonomic revision and relationships. Ph.D dissertation. Iowa State University, Ames, Iowa.

Larsen, K. 1960. Cytological and experimental studies on the flowering plants of the Canary Islands. *K. Danske Videnskab. Selskab. Biol. Skr.* 11,3: 1-60.

Laurent, E. 1891. Rescherches sur les nodosités radicales des legumineuses. *Ann. Inst. Pasteur* 5: 105-139.

Lavin, M. 1987. A cladistic analysis of the tribe Robinieae (Papilionoideae, Leguminosae. In C.H. Stirton (Editor), *Advances in Legume Systematics, Part 3.* pp. 31-64. Royal Botanic Gardens, Kew.

Lavin, M. 1988. Systematics of *Coursetia* (Leguminosae-Papilionoideae). *Systematic Botany Monographs* 21: 1-167.

Lazaro, F.B. 1966. *Semillas y plantulas de leguminosas pratenses Españolas*. Instit. Forest. des Investig. y Exper., Madrid. 248 pp.

Leadingham, G.F. 1957. Chromosome numbers of some Saskatchewan Leguminosae with particular reference to *Astragalus* and *Oxytropis*. *Canad. J. Bot.* 35,5: 657-666.

Lèonard, J. 1957. Genera des Cynometreae et des Amherstieae africaines (Leguminosae-Caesalpinioideae). Essai de blastogenie appliquee ala systematique. *Acad. Mem. Roy. Belg., Classe de Sci.* 30,2: 1-312.

Lersten, N.R. and Wemple, D.K. 1966. The discontinuity plate: a definitive floral characteristic of the Psoraleae (Leguminosae). *Amer. J. Bot.* 53: 548-555.

Levyns, M.R. 1934. Revision of the genus *Lobostemon*. *J. Linn. Soc. (Bot.)* 49: 393-451.

Levyns, M.R. 1938. Some evidence bearing on the past history of the Cape flora. *Trans. Roy. Soc. S. Afr.* 26: 401-424.

Levyns, M.R. 1952. Clues to the past in the Cape Flora of today. *S. Afr. J. Sci.* 49: 155-164.

Levyns, M.R. 1964. Migrations and origin of the Cape Flora. *Trans. Roy. Soc. S. Afr.* 37: 85-107.

Li, S.-J. 1978. Seedling variation of open-pollinated seeds from a single tree of *Acacia confusa* Merr. *Kew Bull.* 32,3: 537-539.

Linde, van der W.J., Clemitson, J.G. and Crous, M.E. 1959. Plant parasitic nematodes. *Sci. Bull. entomol. Ser.* 44: 3-16.

Linder, H.P. 1983. The historical phytogeography of the Disinae (Orchidaceae). *Bothalia* 14,3-4: 565-570.

Linder, H.P. 1983. Gene flow, speciation, and species diversity patterns in a species-rich area: the Cape Flora. In E.S. Vrba (Editor), *Species and Speciation.* pp. 53-57. Transvaal Museum Monograph No. 4. Transvaal Museum, Pretoria.

Linnaeus, C. (Filius). 1781. *Supplementum Plantarum Systematis Vegetabilium Editionis Decimae Tertiae, Generum Plantarum Editionis Sextae, et Specierum Plantarum Editionis Secunda.* Brunsvigae, impensis Orphanotrophei.

Löve, A. and Löve, D. 1982. IOPB Chromosome number reports. LXXIV. *Taxon* 31: 120-126.

Loveless, M.B. and Hamrick, J.L. 1984. Ecological determinants of genetic structure in plant populations. *Ann. Rev. Ecol. Syst.* 15: 65-95.

Lövtrup, S. 1974. *Epigenetics, A Treatise on Theoretical Biology.* J. Wiley & Sons, New York.

Lubbock, J. 1892. *A contribution to our knowledge on seeds and seedlings.* Vols. 1&2. Kegan Paul, Trench & Treubner, London.

Lucas, G. and Synge, H. 1981. The assessment and conservation of threatened plants around the world. In H. Synge (Editor), *The Biological Aspects of Rare Plant Conservation.* pp. 3-18. Wiley-Interscience, Chichester.

Lundgren, J. 1972. Revision of the genus *Anaxeton* Gaertn. (Compositae). *Opera Bot.* 31: 1-59.

Luttge, U. 1971. Structure and function of plant glands. *Ann. Rev. Plant Physiol.* 22: 23-44.

Ma, X.H., Qin, R.L. and Xing, W.B. 1984. Chromosome observations of some medical plants in Xinjang. *Acta Phytotax. Sin.* 22,3: 243-249.

Maddison, W.P, Donoghue, M.J. and Maddison, D.R. 1984. Outgroup analysis and parsimony. *Syst. Zool.* 33: 83-103.

Maekawa, F. 1955. Topo-morphological and taxonomical studies in Phaseoleae, Leguminosae. *Jap. J. Bot.* 15: 103-116.

Malla, S.B., Bhattari, S., Gorkhali, M., Saiju, H. and Singh, M.P. 1977. In IOPB chromosome number reports. LVII. *Taxon* 26: 443-452.

Markert, C.L. 1983. Isozymes: conceptual history and biological significance. In Whitt, G.S. (Editor), *Isozymes: Current Topics in Biological and Medical Research* 7: 1-17.

Marloth, R.H. 1908. *Das Kapland.* Fischer, Jena.

Marloth, R.H. 1915. The effects of drought and some other causes on the distribution of plants in the Cape region. *S. A. J. Sci.* 26: 154-159.

Marshall, H.S. 1937. The dates of publication of Ecklon and Zeyher's "Enumeratio" and E. Meyer's "Commentario". *J. Soc. Biblio. Nat. Hist.* 1: 101-103.

Martin, P.G., Boulter, D. and Penny, D. 1985. Angiosperm phylogeny studied using sequences of five macromolecules. *Taxon* 34: 393-400.

Massey, J.R. and Whitson, P.D. 1980. Species biology: the key to plant preservation. *Rhodora* 82: 97-103.

Mayr, E. 1974. Cladistic analysis or cladistic classification? *Z. Zool. syst. Evolut.-forsch.* 12: 94-128.

McMurray, E.B. and Fisk, E.L. 1936. Vascular anatomy of the seedling of *Melilotus alba*. *Bot. Gaz.* 98: 121-134.

McNeill, J. 1986. Proposals on lectotypification and the report of the Committee on Lectotypification. *Taxon* 35: 867-880.

McNeill, J., Odell, E.A., Consaul, L.L. and Katz, D. 1987. American Code and later typifications of Linnaean generic names dating from 1753: a case study of the discrepancies. *Taxon* 36,2: 350-401.

Meeuse, A.D.J. 1981. Again: Cladistics in Botany. *Taxon* 30,3: 642-643.

Meijer Drees, E. 1941. Germination and seedlings of some *Acacia* species. *Tectona* 34: 1-45.

Meissner, C.F. 1843. Leguminosae. *Hook., Lond. J. Bot.* 2: 60-105.

Mertz, D.B. 1971. The mathematical demography of the California Condor population. *Amer. Nat.* 105: 437-453.

Meyer, E.H.F. 1832. Plantae Ecklonianae: Leguminosae. *Linnaea* 7: 145-173.

Meyer, E.H.F. 1836. Comentariorum de Plantis AfricaeAustralioris quas per octo annos collegit observationibusque manuscriptis illustravit Johannes Franciscus Drege. Voss, Leipzig.

Mickevich, M.F. 1982. Transformation series analysis. *Syst. Zool.* 31: 461-478.

Mishler, B.D., Bremer, K. Humphries, C.J. and Churchill, S.P. 1988. The use of nucleic acid sequence data in phylogenetic reconstruction. *Taxon* 37: 391-395.

Morton, J.K. 1972. Phytogeography of the West African Mountains. In D.H. Valentine (Editor), *Taxonomy, Phytogeography and Evolution.* Academic Press, London.

Mostert, J.W.C. 1955. Observations on the nodulation of some leguminous species. *Farm. S. Afr.* 30: 338-340.

Muller, F.M. 1978. *Seedlings of the North-western Lowland: Flora of seedlings*. W. Junk, Den Hague.

Myers, N. 1987. The extinction spasm impending: synergisms at work. *Biological Conservation* 1,1: 14-21.

Napp-Zinn, K. 1973. Anatomie des blattes II. Blattanatomie der Angiospermen. In *Handbuch der Pflanzenanatomie* 7:2A Number 1. Gebruder Bontraeger, Berlin & Stuttgart.

Natarajan, G. 1977. *Contribution a L'etude caryosystematique des espèces de la garrique languedocienne.* Thesis, Academie de Montpellier, Paris.

Natarajan, G. 1978. In IOPB chromosome number reports LX11. *Taxon* 27; 519-535.

Naudin, C. 1897. Nouvelles recherches sur les tubercules et les nodosités des Légumineuses et sur leurs rapports avec ces plantes. *J. Agric. Prat.* 61: 46-51.

Nelson, G.J. 1975. Historical biogeography: an alternative formulation. *Syst. Zool.* 23: 555-558.

Nelson, G.J. 1978. Ontogeny, phylogeny, and the biogenetic law. *Syst. Zool.* 27: 324-345.

Nelson, G.J. and Platnick, N. 1981. *Systematics and Biogeography: Cladistics and Vicariance*. pp. 524-537. Columbia University Press, New York.

Neticks, Filo G. 1978. Derived characters I have known. *Syst. Zool.* 27,2: 238-239.

Ng, F.S.P. 1975. The fruits, seeds and seedlings of Malayan trees. I-Xi. *Malaya For.* 38: 33-39.

Nongonierma, A. 1971. Contribution à L'etude systematique des *Tephrosia* (Papilionaceae) de L'Ouest africain: Utilisation et valeur des caractères des graines et des plantules. *Bull. Inst. Fond. Afr. Noire* 33: 775-937.

Nordenstam, B. 1969. Phytogeography of the genus *Euryops* (Compositae). A contribution towards the phytogeography of southern Africa. *Opera Bot.* 23: 1-77.

Norris, D.O. 1959. The role of calcium and magnesium in the nutrition of *Rhizobium*. *Austr. J. Agric. Res.* 10,5: 651-698.

Nozolillo, C. 1973. A survey of anthocyanin pigments in seedling legumes. *Can. J. Bot.* 51: 911-915.

Nozolillo, C. and McNeill, J. 1985. Anthocyanin pigmentation in seedlings of selected species of *Phaseolus* and *Vigna* (Fabaceae). *Can. J. Bot.* 63: 1066-1071.

Ockenden, D.J. 1965. A taxonomic study of *Psoralea* subgenus *Pediomelum* (Leguminosae). *Southw. Nat.* 10: 81-124.

Ockenden, D.J., Alston, R.E. and Naifeh, K. 1965. The flavonoids of *Psoralea* (Leguminosae). *Phytochemistry* 5: 601-

Ohashi, H. 1973. The Asiatic species of *Desmodium* and its allied genera. *Ginkgoana* 1: 1-318.

Oliver, D. 1885. J. Linn. Soc. 21: 399.

Oliver, E.G.H. 1977. An analysis of the Cape flora. *Proceedings 2nd Nat. Weeds Conf. S. Afr.* 2: 1-18.

Oliver, E.G.H., Linder, H.P. and Rourke, J.P. 1983. Geographical distribution of present-day Cape taxa and their phytogeographical significance. *Bothalia* 14, 3-4: 427-440.

Palmer, J.D., Jorgenson, R.A. and Thompson, W.F. 1985. Chloroplast DNA variation and evolution in *Pisum*; patterns of change and phylogenetic analysis. *Gemnetics* 109: 195-213.

Palmer, J.D. 1985. Evolution of chloroplast and mitochondrial DNA in plants and algae. In R.J. MacIntyre (Editor), *Monographs in Evolutionary Biology: Molecular Evolutionary Genetics*. pp. 131-240.

Patel, J.D. and Venkateswara, Rao N. 1975. Shoot apical organization in seedlings of some Indian pulses. *Phyton (Austria)* 17: 109-119.

Patterson, C. 1982. Morphological characters and homology. In K.A. Joysey and A.E. Friday (Editors), *Problems of Phylogenetic Construction*. pp. 21-74. Academic Press, London & New York.

Payne, W.W. 1976. Biochemistry and species problems in *Ambrosia* (Asteraceae-Ambrosieae). *Pl. Syst. Evol.* 125: 169-178.

Pearcy, R.W. and Ehleringer, J. 1984. Comparative ecophysiology of C_3 and C_4 plants. *Plant. Cell. Environ.* 7: 1-13.

Phillips, E.P. 1926. The Genera of South African Flowering Plants. *Mem. Bot. Surv. S. Afr.* 10: 1-702.

Pillai, A. and Sharma, K.C. 1983. Seedling anatomy of some Mimosoideae. *Feddes Repert.* 94: 225-231.

Pimental, R.A. and Riggins, R. 1987. The nature of cladistic data. *Cladistics* 3,3: 201-209.

Platnick, N. 1979. Philosophy and transformation of cladistics. *Syst. Zool.* 28: 537-546.

Platnick, N. 1986. On justifying cladistics. *Cladistics* 2,1: 83-85.

Platnick, N. and Cameron, H.D. 1977. Cladistic methods in textual, linguistic, and phylogenetic analysis. *Syst. Zool.* 26: 380-385.

Podlech, D. and Dieterlen, A. 1969. Chromosomen studien an Afganischen Pflanzen. *Candollea* 24: 185-243.

Poiret, J.L.M. 1794. *Encyclopedie Methodique*. Paris.

Polhill, R.M. 1976. Genisteae (Adans.) Benth. and related tribes (Leguminosae). *Botanical Systematics* 1: 143-368.

Polhill, R.M. and Raven, P.H. 1981. (Editors). *Advances in Legume Systematics, Part 1.* Royal Botanic Gardens, Kew.

Polhill, R.M., Raven, P.H. and Stirton, C.H. 1981. Evolution and systematics of the Leguminosae. In R.M. Polhill and P.H. Raven (Editors). *Advances in Legume Systematics, Part 1.* pp. 1-26. Royal Botanic Gardens, Kew.

Pollard, J.F. (Editor). 1985. *Evolutionary Theory: Paths into the Future.* John Wiley & Sons, Chichester.

Poncy, O. 1986. Le genre *Inga* (Légumineuses, Mimosoideae) en Guyane Francaise. *Mem. Mus. nat. Hist. Natur.*, Sèr. B. Botanique. volume 31.

Poynton, J.C. 1983. The dispersal versus vicariance debate in biogeography. *Bothalia* 14,3-4: 455-460.

Prentice, H.C. 1976. A study in endemism: *Silene diclinis. Biol. Conserv.* 10: 15-30.

Rabinowitz, D. 1978. Abundance and diaspore weight in rare and common prairie grasses. *Oecologia (Berlin).* 37: 213-219.

Rabinowitz, D. 1981. Seven forms of rarity. In H. Synge (Editor), *The Biological Aspects of Rare Plant Conservation.* pp. 205-217. Wiley-Interscience, Chichester.

Raghavan, R.S. 1959. Chromosome numbers in Indian medicinal plants. *Proc. Ind. Acad. Sci., Sect. B.* 49,4: 239-244.

Raikow R.J. 1981. Problems in Avian classification. *Curr. Ornith.* 2: 187-212.

Raven, P.H. 1987. The scope of the plant conservation problem worldwide. In Bramwell, D., Hamman, O., Heywood, V.H. and Synge, H. 1987. *Botanic Gardens and the World Conference Strategy.* pp. 19-29. Academic Press, London.

Raven, P.H., Khyos, D.W. and Hill, A.J. 1965. Chromosome numbers of spermatophytes, mostly Californian. *Aliso* 6: 105-113.

Riddiford, A. and Penny, D. 1985. The scientific status of evolutionary theory. In J.F. Pollard (Editor), *Evolutionary Theory: Paths into the Future.* pp. 1-38. John Wiley & Sons, Chichester.

Rees, H. and Narayan, R.K.J. 1981. Chromosomal DNA in plants. *Proc. Roy. Soc.*, B, 292: 569-578.

Rees, H. and Narayan, R.K.J. 1988. Biological implications of genome evolution. In C.H. Stirton & J. Zarucchi (Editors), *Advances in Legume Biology* (In press).

Richardson, I.B.K. 1978. Endemic taxa and the taxonomist. In H.E. Street (Editor), *Essays in Plant Taxonomy.* pp. 245-262. Academic press, London & New York.

Riedl, R. 1986. The role of morphology in the theory of evolution. In M. Grene (Editor), *Dimensions of Darwinism*. pp. 205-238. Cambridge University Press, Cambridge.

Robbertse, P.J. and van der Schijff, H.P. 1975. The genus *Acacia* Miller in South Africa. 5. (With special reference to the seedling structure as a taxonomic characteristic). *Mitt. Bot. Staatsamml. München* 10:170-177.

Rodman, J.E. 1981. Divergence, convergence, and parallelism in phytochemical characters: The glucosinolate-myrosinase system. In D.A. Young and D.S. Seigler (Editors), *Phytochemistry and angiosperm phylogeny*. pp. 43-79. Praeger, New York.

Rohrbach, P. 1870. Beiträge zur Morphologie der Leguminosen. *Bot. Zeitung* 28: 817-829.

Rourke, J.P. 1980. *The Proteas of Southern Africa*. Purnell, Cape Town.

Rydberg, P.A. 1919. Fabaceae: Psoraleeae. *Fl. N. Amer.* 24: 1-64.

Rydberg, P.A. 1928. Genera of North American Fabaceae. III. Tribe Psoraleeae and IV. Tribe Psoraleeae (contd.). *Amer. J. Bot.* 15: 195-203.

Saether, O.A. 1986. The myth of objectivity - Post-Hennigian deviations. *Cladistics* 2,1: 1-13.

Salter, T.M. 1939. Amalgamation of the genus *Hallia* Thunb. with *Psoralea* Linn. *Jl. S. Afr. Bot.* 5:45-46.

Samanta, P. and Datta, P.C. 1975. Chromosome variation in relation to leaf structure of *Psoralea corylifolia* L. *Acta Soc. Bot. Pol.* 44,2: 305-311.

Sarkar, A.K., Datta, N. and Chatterjee, U. 1972. Chromosome survey of certain Angiosperms. *Bull. Bot. Surv. India* 14: 170.

Sastrapradja, D., Sastrapradja, S., Aminah, S.R. and Lubis, I. 1975. Species differentiation in Javanese *Mucuna* with particular reference to seedling morphology. *Ann. Bog.* 6: 57-68.

Sattler, R. 1987. *Biophilosophy: Analytic and Holistic Perspectives*. Springer-Verlag, Berlin.

Seberg, O. 1988. Taxonomy, phylogeny, and biogeography of the genus *Oreobolus* R.Br. (Cyperaceae), with comments on the biogeography of the South Pacific continents. *Bot. J. Linn. Soc.* 96: 119-195.

Schaffer, M.L. 1981. Minimum population sizes for species conservation. *Bioscience* 31: 131-134.

Schlechter, R. 1897. Plantae Schlechterianae novae vel minus cognitae describuntur. *Bot. Jb.* 24: 433-459.

Schonland, S. 1914. On some new and little known South African Plants. *Rec. Albany Mus.* 3: 52-64.

Schrire, B. 1989. Floral biology of the Leguminosae. In C.H. Stirton and J. Zarucchi (Editors). *Advances in Legume Biology, Vols. 1 & 2.* Missouri Botanical Garden Monograph Series, St. Louis. 750 pp. (in press).

Shorrocks, B. (Editor). 1984. *Evolutionary Ecology*. Blackwell, Oxford.

Sims, J. 1819. *Psoralea arborea*. Bot. Mag. 1819h.

Simmonds, M. 1988. Personal communication.

Simmons, J.B., Beyer, R.L., Brandham, P.E., Lucas, G.Ll. and Parry, V.T.H. (Editors). 1976. *Conservation of Threatened Plants*. Plenum Press, New York and London.

Smith , D.L. 1981. Cotyledons of the Leguminosae. In R.M. Polhill and P.H. Raven (Editors), *Advances in Legume Systematics, Part 2.* pp. 927-940. Royal Botanic Gardens, Kew.

Smith, D.L. 1983. Cotyledon anatomy of the Leguminosae. *Bot. J. Linn. Soc.* 87: 325-355.

Smith, D.L. and Scott, R.C. 1985. Cotyledon venation patterns in the Leguminosae: Caesalpinioideae. *Bot. J. Linn. Soc.* 90: 73-103.

Sokal, P.R. and Sneath, P.H.A. 1963. *Principles of Numerical Taxonomy.* W.H. Freeman, San Francisco.

Solereder, H. 1908. *Systematic Anatomy of the Dicotyledons.* English Edition. Translated by L.A. Boodle and F.E. Fritsch. 2 vols. Clarendon Press, Oxford.

Soulé, M.E. 1983. What do we really know about extinction? In Schonewald-Cox, S.M. Chambers, B. MacBryde and W.L. Thomas (Editors), *Genetics and Conservation*. pp. 111-124. Benjamin Cummings, Menlo Park.

Soulé, M.E. 1985. What is conservation Biology? *Bioscience* 35,11: 727-734.

Soulé, M.E. (Editor). 1986. *Conservation Biology: The Science of Scarcity and Diversity*. Sinauer Associates, Sunderland.

Soulé, M.E. and Wilcox, B.A. (Editors). 1980. *Conservation Biology: An Evolutionary-ecological Approach*. Sinauer Associates, Sunderland.

Sousa, S.M. and Pena de Sousa, M. 1981. New World Lonchocarpinae. In R.M. Polhill and P.H. Raven (Editors), *Advances in Legumes Systematics, Part 2.* pp. 261-282. Botanic Gardens, Kew.

Spies, J.J. and Stirton, C.H. 1982. Meiotic studies of some South African cultivars of *Lantana camara* (Verbenaceae). *Bothalia* 14,1: 101-111.

Spies, J.J., Stirton, C.H. and du Plessis, H. 1987a. The genus *Rubus* in South Africa. IV. Hybridization. *Bothalia* 17,1: 105-119.

Stebbins, G.L. 1980. Rarity of plant species: a synthetic viewpoint. *Rhodora* 82: 77-86.

Stebbins, G.L. and Major, J. 1965. Endemism and speciation in the Californian flora. *Ecol. Monogr.* 35: 1-35.

Steele, E.J., Gorczynski, R.M. and Pollard, J.W. 1985. In J.F. Pollard (Editor), *Evolutionary Theory: Paths into the Future*. 217-238. John Wiley & Sons, Chichester.

Stevens, P. 1980. Evolutionary polarity of characters. *Ann. Rev. Ecol. Syst.* 11: 333-358.

Stirton, C.H. 1977. Some thoughts on the polyploid complex *Lantana camara* L. (Verbenaceae). In D.P. Annecke (Editor), *Second National Weeds Conference in Southern Africa*, pp. 321-340. Balkema, Cape Town.

Stirton, C.H. (Editor). 1978. *Plant Invaders, Beautiful but Dangerous*. Department of Nature and Environmental Conservation of the Cape Provincial Administration. Cape Town. 175 pp.

Stirton, C.H. 1979. Taxonomic problems associated with invasive alien trees and shrubs in South Africa. In G. Kunkel (Editor), *Taxonomic aspects of African Taxonomic Botany*, pp. 218-229. ECXMO, Las Palmas.

Stirton, C.H. 1981a. Studies in the Leguminosae - Papilionoideae of southern Africa. *Bothalia* 13,3-4: 317-325.

Stirton, C.H. 1981b. Psoraleeae. In R.M. Polhill and P.H. Raven (Editors), *Advances in Legumes Systematics, Part 2.* pp. 337-343. Royal Botanic Gardens, Kew.

Stirton, C.H. 1981c. Natural hybridization in the genus *Eriosema* (Leguminosae) in South Africa. *Bothalia* 13,3-4: 307-315.

Stirton, C.H. 1981d. Petal sculpturing in Papilionoid Legumes. In R.M. Polhill and P.H. Raven (Editors), *Advances in Legumes Systematics, Part 2.* pp. 771-788. Royal Botanic Gardens, Kew.

Stirton, C.H. 1982. A new species of *Otholobium* in South Africa. *Bothalia* 14: 72-73.

Stirton, C.H. 1983a. Two new species of *Otholobium* (Fabaceae). *Jl. S. Afr. Bot.* 49: 337-342.

Stirton, C.H. 1983b. Two new species of *Psoralea* (Fabaceae). *Jl. S. Afr. Bot.* 49: 329-335.

Stirton, C.H. 1984. Name changes in *Psoralea* (Fabaceae). *Jl. S. Afr. Bot.* 50,4: 461-462.

Stirton, C.H. 1985a. Notes on the genus *Otholobium* (Psoraleeae, Fabaceae). *S. Afr. J. Bot.* 52: 1-6.

Stirton, C.H. 1985b. Book review of V.H. Heywood & D.M. Moore, *Current concepts in Plant Taxonomy*, *Annals. Bot.* 56: 277-279.

Stirton, C.H. (Editor). 1987. Preface. *Advances in Legume Systematics, Part 3.* Royal Botanic Gardens, Kew.

Stirton, C.H. 1989. The genus *Otholobium* (In preparation).

Stirton, C.H., Field, D.V., Brummitt, R.K., and McNeill. 1981. Principles of lectotypification. *Taxon* 30: 251-256.

Stirton, C.H. and J. Zarucchi (editors). 1989. *Advances in Legume Biology, Vols. 1 & 2.* Missouri Botanic Garden Monograph Series, St. Louis. 750 pp. (in press).

Stott, P. 1981. *Historical Plant Geography.* George Allen & Unwin, London.

Subramanian, D. 1972. Karyotype analyses in some wild leguminous plants. *Proc. Ind. Sci. Congr. Assoc.* 59: 358-359.

Sukopp, H. and Trautmann, W. 1981. Causes of the decline of threatened plants in the Federal Republic of Germany. In H. Synge (Editor), *The Biological Aspects of Rare Plant Conservation*. pp. 113-116. Wiley-Interscience, Chichester.

Takhtajan, A. 1969. *Flowering Plants: Origin and Dispersal.* Edinburgh : Oliver & Boyd.

Taubert, P. 1894. Leguminosae. In H. Engler and K. Prantl (Editors). *Die Natrlichen Familien*. Engelmann, Leipzig.

Taylor, H.C. 1978a. Capensis. In M.J.A. Werger (Editor), *Biogeography and Ecology of Southern Africa*, pp. 171-229. Junk, Den Haag.

Taylor, H.C. 1978b. Phytogeography. In J. Day, W.R. Siegfried, G.N. Louw, and M.L. Jarman (Editors), *Fynbos Ecology, A preliminary Synthesis*. pp. 70-81. S. A. Nat. Sci. Progr. Report No. 40.

Taylor, H.C. 1980. Phytogeography of fynbos. *Bothalia* 13: 231-235.

Temin, H.M. and Engels, W. 1985. Movable genetic elements and evolution. In J.F. Pollard (Editor), *Evolutionary Theory: Paths into the Future*. pp. 173-202. John Wiley & Sons, Chichester.

Terborgh, J. and Winter, B. 1980. Some causes of extinction. In M.E. Soulé and B.A. Wilcox (editors), *Conservation biology: An Evolutionary-ecological Perspective*. pp. 119-133. Sinauer Associates, Sunderland.

Tewari, R.B. and Nair, P.K.K. 1979. Wing morphology of the flower in some Galegeae (Papilionaceae). *Brenesia* 16: 131-138.

Thombre, M.V. 1959. Chromosome numbers in some common flowering plants. *Sci. & Cult.* 25,3: 308.

Threatened Plants Committee Secretariat. 1980. *IUCN Categories*. IUCN, Kew. 9 pp.

Thunberg, C. 1799. Observationes in genus Halleriae. *Nova Acta R. Soc. Sci. Uppsal.* 6: 38-40.

Thunberg, C. 1823. *Flora Capensis*. Uppsala.

Troll, W. 1964. *Die Inflorezenzen 1.* Fisher, Jena.

Troll, W. 1969. *Die Inflorezenzen 2(1).* Fisher, Stuttgart.

Tschechow, W. 1930. Karyologish-systematische Untersuchung des Tribus Galegeae. *Planta* 9,4: 673-680.

Tschechow, W. 1931. Caryosystematitcheskoe issledovanie tribusov Sophoreae Spreng., Podalarieae Benth. i Genisteae Bronn. sem. Leguminosae. Izv. *Tomsk. otd. Gos. russk. bot. obshtch.* 3, 1-2: 121-131.

Tucker, S.C. 1987a. Pseudoracemes in papilionoid legumes; their nature, development, and variation. *Bot. J. Linn. Soc.* 95: 181-206.

Tucker, S.J. 1987b. Floral initiation and development in legumes. In C.H. Stirton (Editor), *Advances in Legume Systematics, 3.* pp. 183-339. Royal Botanic Gardens, Kew.

Tucker, S.J. and Stirton, C.H. 1989. The nature of the cupulum in *Psoralea* (Psoraleeae, Leguminosae). *Bot. J. Linn. Soc.* (In press).

Turner, B. 1956. Chromosome numbers in the Leguminosae. *Amer. J. Bot.* 43,8: 577-582.

Turner, B. and Fearing, O.S. 1960. Chromosome numbers in the leguminosae. III. Species of the south-western United States and Mexico. *Amer. J. Bot.* 47,7: 603-608.

Turner, G.W. 1984. Secretory Cavities in Amorpheae and Psoraleeae (Leguminosae: Papilionoideae): Anatomy, Development, Distribution and Significance for Tribal Relationships. M. Sc. Thesis. Iowa State University.

Turner, G.W. 1986. Comparative development of secretory cavities in the tribes Amorpheae and Psoraleeae (Leguminosae; Papilionoideae). *Amer. J. Bot.* 73,8: 1178-1192.

Tuteja, S. and Bhatt, R.P. 1984. In IOPB chromosome numbers of plants, LXXXV. *Taxon* 33: 758.

Van Loon, J. 1974. A cytological investigation of flowering plants from the Canary Islands. *Acta bot. Neerl.* 23: 113-124.

Van Valen, L. 1978. Why not to be a cladist. *Evolutionary Theory* 3: 285-299.

Vassal, J. 1972. Rapport des recherches ontogeniques et seinologiques a'l'etude morphologique, taxonomique et phylogehique du genre *Acacia. Bull. Soc. Hist. Nat. Toulouse* 108: 125-247.

Vassiliczenko, I.T. 1937. Morphologie der keimung der Leguminosen in Zusammenhang mit ihrer Systematik und Phylogenie. *Act. Inst. Bot. Acad. Scient. URSS*, ser. 1,4: 347-425.

Vavilov, N. 1922. The law of homologous series in the inheritance of variability. Translated and published in 1954. *Chronica Botanica* 13: 55-94.

Vishnu-Mittre, B. and Sharma, B.D. 1962. Studies of Indian pollen grains, 1. Leguminosae. *Pollen Spores* 4: 5-45.

Von Hohnel, F.R. 1881. Anatomische Untersuchungen ueber einige Secretionsorgane der Pflanzen. *Sber. Akad. Wiss. Wien, Math.-Nat. Cl.* 84: 565-603.

Vuillemin, P. 1891. Sur l'evolutionde l'appareil secreteur des Papilionacees. *Bull. Soc. Bot.* 38: 193-200.

Waddle, R.M. and Lersten, N.R. 1974. Morphology of discoid floral nectaries in Leguminosae, especially tribe Phaseoleae (Papilionoideae). *Phytomorphology* 23: 152-161.

Walker, J.W. and Doyle, J.A. 1976. The bases of angiosperm phylogeny: palynology. *Ann. Missouri Bot. Gard.* 62: 664-722.

Walpers, G.W. 1842. *Repertorium Botanices Syatemaicae.* 7 vols. Leipzig.

Walters, S.M. 1981. Priorities in rare species conservation for the 1980s. In H. Synge (Editor), *The Biological Aspects of Rare Plant Conservation*. pp. xxv-xxvii. Wiley-Interscience, Chichester.

Wanntorp, H.E. 1980. Theory and dogma in systematics. *Taxon* 29: 668-670.

Ward, D.E. 1983. Chromosome counts from New Mexico and southern Colorado. *Phytologia* 54: 302-309.

Warren, J.A. 1909. Additional notes on the number and distribution of native legumes in Nebraska and Kansas. *U. S. Dept. Agric. Bur. Plant Ind. Circ. 31.* 9 pp.

Wattrous, L.E. and Wheeler, Q.D. 1981. The outgroup comparison method of character analysis. *Syst. Zool.* 30: 1-11.

Webberling, F. 1983. Fundamental features of modern inflorescence morphology. *Bothalia* 14,3: 917-922.

Webberling, F. 1988. Structure and evolutionary tendencies of inflorescences in the Leguminosae. In C.H. Stirton and J. Zarucchi (Editors), *Advances in Legume Biology*, Missouri Botanical Garden Monograph Series, St. Louis (In press).

Webberling, F. and Leenhouts, P.W. 1966. Systematisch-morphologische Studien an Terebinthales-Familien (Burseraceae, Simaroubaceae, Meliaceae, Anacardiaceae, Sapindaceae. *Abh. Akad. Wiss. Lit., Math-Naturw. Klasse, Jahrg.* 1965. 10: 536-571.

Weimarck, H. 1933. Die verbreitung einiger Afrikanisch-montanen Pflanzengruppen. I-II. *Svensk bot. Tidskr.* 27: 400-419.

Weimarck, H. 1934. *Monograph of the genus Cliffortia.* Ohlsson, Lund.

Weimarck, H. 1936. Die verbreitung einiger Afrikanisch-montanen Pflanzengruppen. III-IV. *Svensk bot. Tidskr.* 30: 35-56.

Weimarck, H. 1940. *Monograph of the genus Aristea.* Gleerup, Lund.

Weimarck, H. 1941. Phytogeographical groups, centres and intervals within the Cape flora. *Lunds Univ. Arsskr. Avd. 2*; 37,5: 1-143.

Wells, P.V. 1969. The relation between mode of reproduction and extent of speciation in woody genera of the California chapparal. *Evolution* 23: 264-267.

Wemple, D.K. and Lersten, N.R. 1966. An interpretation of the flowers of *Petalostemon* (Leguminosae). *Brittonia* 18: 117-126.

Weyland, J. 1893. Beitrage zur anatomischen characteristik der galegeen. *Bull. Herb. Boisier* 1, Appendix 3:109-200.

White, F. 1978. The afro-montane region. In M.J.A. Werger (Editor), *Biogeography and Ecology of southern Africa*. Junk, The Hague.

Whitt, G.S. 1983. Isozymes as probes and participants in developmental and evolutionary genetics. In M.C. Rattazzi, J.E. Scandalios and Whitt, G.S. (Editors), *Isozymes: Current Topics in Biological and Medical Research* 7: 1-46.

Wild, H. 1964. The endemic species of the Chimanimani Mountains and their significance. *Kirkia* 4: 125-157.

Wild, H. 1968. Phytogeography of South Central Africa. *Kirkia* 6: 197-222.

Wild, H. 1975. Phytogeography and the Gondwanaland position of Madagasgar. *Boissiera*. 24: 107-171.

Wiley, E.O. 1981. *Phylogenetics: The Theory and Practice of Phylogenetic Systematics*. John Wiley & Sons, New York.

Williams, I.J.M. 1975. A revision of the genus *Leucodendron* (Proteaceae). *Contrib. Bolus Herb.* 3: 1-425.

Wilson, J.K. 1939. Leguminous plants and their associated organisms. *Cornell Univ. Agric. Exp. Stn. Mem. 221.* 48pp.

Ye, N. 1983. Descriptions of various seedlings of leguminous plants. *Phytologia* 54,3: 190-218.

Zandee, R. and Geesink, R. 1987. Phylogenetics and legumes: a desire for the impossible? In C.H. Stirton (Editor), *Advances in Legume Systematics, Part 3.* pp. 131-167. Royal Botanic Gardens, Kew.

Zijlstra, G. 1986. Proposals to amend the code with regard to lectotypification. *Taxon* 35: 854-867.

Zindler-Frank, E. 1987. Calcium oxalate crystals in Leguminosae. In C.H. Stirton (Editor), *Advances in Legume Systematics, Part 3.* pp. 279-316. Royal Botanic Gardens, Kew.

Zurawski, G. and Clegg, M.T. 1987. Evolution of higher plant chloroplast DNA-encoded genes: implications for structure-function and phylogentic studies. *Ann. Rev. Pl. Physiol.* 38: 391-418.

APPENDICES

Table of contents

APPENDIX 1

Draft Working Checklist of the genus *Psoralea*

1-2-1989.

Psoralea L., Sp. Pl. 762 (1752); Berg., Descr. pl. Cap. 218 (1767); Miller, Gard. Dict., ed. 8 (1768); Gaertn., Fruct. 2: 308, t.145 (1791); Poir. in Lam., Encycl. 5: 680 (1804); Dietrich, Lex. Gart. Bot. 7: 606 (1807); DC., Prodr. 2: 216 (1825); Endl., Gen. 6526 (1839); G. Don., Gen. Syst. 2: 210 (1832); Meisn., Pl. Vasc. Gen. altera 61 (1838); Walpers, Repert. 1: 655 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 143 (1862); Harv., Gen. 77 (1868); Baillon, Hist. Pl. 2: 284 (1870); Taubert, Naturf.-Pflanzen. 3,3: 262 (1892); Sims, For. & For. Fl. Cape Good Hope 198 (1907); Phillips, Gen. S. Afr. Pl. 326 (1926); Forbes in Bothalia 3: 3 (1930); Salter, Jl. S. Afr. Bot. 5: 45 (1939); Lemeè, Dict. 5: 636 (1934); Adamson & Salter, Fl. Cape Penins. 486 (1950); Dyer, Gen. 257 (1975); Palmer & Pitman, Trees S. Afr. 2: 917 (1972); Compton, Fl. Swaziland 265 (1976); Stirton in Adv. Leg. Syst. 1:337 (1981).

Type: *Psoralea pinnata* L.

> *Hallia* Thunb. in Schrad. Journal 1: 317 (1799); Harv. in Harv. & Sond., Fl. Cap. 2: 231 (1862); Salter in Jl. S. Afr. Bot. 5:45 (1939); Hutch., Gen. 419 (1964) non Jaume St. Hillaire (1812). Type: *Hallia monophylla* (L.) Schindler.
>
> *Ruteria* Medikus, Phil. Bot. Fasc. 1: 208 (1789).

abbottii C.H. Stirton, sp. nov. Type: Natal, Umtamvuna Nature Reserve, *Abbott 2895* (K, holotype).

aculeata L., Sp. Pl. 1074 (1752); Mant. Pl. altera 450 (1771); Ait., Hort. Kew 3: 79 (1789); Andrews, Bot. Rep. 3: 146 (1801); Dietrich, Lex. Gart. Bot. 7: 606 (1807); Poir. in Lam., Encycl. 5: 688 (1804); Sims, Bot. Mag.47: 2158 (1820); Curtis, Bot. Mag. 47: t.2158 (1820); Trattinck, Gartenpflanz. 1: 63 (1821); Loiseleur-Deslongchamps, Herb. gen. 6: 373 (1822); DC., Prodr. 2: 217 (1825); E. Mey. in Linnaea 7: 166 (1832); G. Don, Gen. Syst. 2: 202 (1832); Drapiez, Herb. amat. 7: 513 (1834); E. Mey., Comm. 85 (1836); Eckl. & Zeyh., Enum. 229 (1836); Richter, Codex 739 (1840); Walpers, Repert. 1: 657 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 149 (1862); Marloth, Fl. S. Afr. 2: 77, t.26.1 (1925); Forbes in Bothalia 3: 130 (1930). Salter in Adamson & Salter, Fl. Cape Penins. 486 (1950); Rice & Compton, Wild Flow. Cape Good Hope, t.42.2 (1950); Kidd, Wild Flowers Cape Penin. t.85.12 (1973); Bond & Goldblatt, Pl. Cape Flora 296 (1984); non Thunb. (1823). Lectotype: *Van Royen* s.n. (L, Sheet 901280.908.121.1270, lectotype). The sheet in S is *Otholobium fruticans* L. and the one in LINN (928.2) is a Sparrman (153) collection determined by L. in 1772. It is the small-leaved form of *P. aculeata*.

> *Genista spartium africanum, trifolium; floribus caeruleis, foliis minimis, in spiculam definentibus.* Rai., Suppl. 104 (1704).
>
> *Cytisi facie lato subrotundo glabro et punctato folio.* Pluk., amalth. 70, t.387, f.6 (1705). This synonym was excluded by L. in his Mant. Pl. altera 450 (1771).

Psoralea foliis ternis, foliolis cuneiformibus, triquetris, aculeatis. Roy., Lugdb. Batav. 373 (1740).

Psoralea foliis ternatis, foliolis cuneiformibus, recurvato-mucronatis, capitulis terminalibus. L., Syst. Plant. 3: 540 (1740).

Psoralea mucronata Thunb., Prodr. 135 (1800); Fl. Cap. 606 (1823); Poiret in Lam., Encycl. 5: 695 (1804). Type: "Cap. Bon. Spei", *Thunberg* s.n. (UPS Thunberg herbarium 17576, holo).

Psoralea decidua Bergius, Descr. Pl. Cap. 220 (1767); Thunb., Fl. Cap. 605 (1823). *Dorychnium decidua* (Berg.) Moench., Suppl. Method. 38 (1802).

Psoralea acuminata Poir. in Lam., Tabl. Encycl. 3: 173, t.614.2 (1794).

Psoralea aculeata L. var. *thunbergiana* Eckl. & Zeyh., Enum. 229 (1836). Type: collector unknown (P, holotype).

Psoralea harveyana Meisn. in Hook., Lond. J. Bot. 11: 82 (1843). Type: Table mountain, *Krauss 898* (W, holotype; NY, isotype?).

Vernacular names: prickly psoralea

affinis Eckl. & Zeyh., Enum. 224 (1836); Walpers in Linnaea 13: 512 (1839); Walpers, Repert 1: 655 (1842); Forbes in Bothalia 3: 126 (1930); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987). Type: "inter frutices (altit. III) laterum montium Van Stadensrivierberge (Uitenhage)", *Ecklon & Zeyher* s.n. (S, lectotype; E, K, L, MO, isolectotype). The sheet in S is the only one which I have seen which bears an original label in their hand so I choose it as the lectotype. Burtt Davy's reference (Fl. Pl. Transv. 375, 1932) to this species is incorrect. His cited specimens refer to *P. latifolia*. The specimen illustrated in Bot. Mag. 136: t.8331 (1910) is not *P. affinis*. It is best referred to *P. arborea* Sims.

Psoralea krebsii Vogel nom. nud.

Psoralea pinnata var. *subglabra* Harv. in Harv. & Sond., Fl. Cap. 2: 144 (1862).

Psoralea arborea Sims sensu Eckl. & Zeyh., Enum. 224 (1836). Correctly noted by Walpers in Linnaea 13: 512 (1839).

alata (Thunb.) Salter in Jl. S. Afr. Bot. 5: 46 (1939); Salter in Adamson & Salter, Fl. Cape Penins. 489 (1950); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987).

Hallia alata Thunb. in Schrad. Journ. 319 (1799); Gen. nov. Pl. 11: 156 (1800); Prodr. 131 (1800); Fl. Cap. 593 (1823); DC., Prodr. 2: 123 (1825); Eckl. & Zeyh., Enum. 172 (1836); E. Mey., Comm. 81 (1836); Harv. in Harv. & Sond., Fl. Cap. 2: 232 (1862). Type: Cape, "in collibus urbis, C.B.S.", *Thunberg* s.n. (Holotype UPS, Thunberg herbarium 17159 & microfische).

Psoralea lathryfolia Balb., Hort. taur. Stirtp. 25, t.5 (1810); Balb. in Mem. Acad. Sci. Turin 18: 361, t.8 (1811); G. Don., Gen. Syst. 2: 202 (1832). Type has apparently been lost. Lectotype: unnumbered plate in Balb. loc.cit.

aphylla L., Pl. rar. afr. 15 (1760); Amoen. acad. 6: 93 (1763); Mant. 450 (1767); Houttyn, Handl. pl.-kruidk. 5: 552 (1776); Poir. in Lam., Encycl. 5: 681 (1804); Dietrich, Lex. Gart. Bot. 7: 607 (1807); Sims in Bot. Mag. 42: 1727 (1815); DC., Prodr. 2;217 (1824) pro parte; E. Mey. in Linnaea 7: 165 (1832); G. Don., Gen. Syst. 2: 202 (1832); Eckl. & Zeyh., Enum. 227 (1836); E. Mey., Comm. 84 (1936); Klinsman, Clav. Breyn. 9 (1855); Harv. in Harv. & Sond., Fl. Cap. 2: 145 (1862); Hamer, Wild Flowers Cape 23, t.71 (1926); Salter in Adamson & Salter,

Fl. Cape Penins. 489 (1950); Forbes in Bothalia 3: 5 (1930); Kidd, Wild Flowers Cape Penins. t.80.4 (1973); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987) non Reichenbach (1822). *Lotodes aphyllum* (L.) O.K., Gen. Pl. 3,2: 65 (1891). Type: Not yet established.

Genista spartium coeruleum capitis bonae spei. Breyne, Exot. pl. cent. 66, t.25 (1678).

Genista spartium aphyllon. Pluk., Amalth. 104 (1705).

Psoralea decidua Berg., Descr. pl. Cap. 220 (1767), nom. illeg. The name is illegitimate since *P. aphylla* L. was given as a synonym and is automatically rejected as being superfluous. non Thunb. (1823).

Psoralea denudata Hoffmannsegg, Verzeichn. Pflanz. 190 (1823), nom. superfl.

Vernacular name: leafless psoralea; bloukeur, fonteinbos.

arborea Sims in Curtis's Bot. Mag. 46: 2090 (1819); DC., Prodr. 2: 216 (1825); E. Mey. in Linnaea 7: 163 (1832); G. Don., Gen. Syst. 2: 201 (1832); E. Mey., Comm. 82 (1836); Walpers, Repert. 1: 655 (1842) non Eckl. & Zeyh. (1836) nec Sessè & Mocin~o (1889). The *P. pinnata* plants referred to by Pitman & Palmer in their book " Trees of Southern Africa (2: 918-919, 1976) are *P. arborea*. Type: Not yet established.

Psoralea pinnata L. var. *quinquijuga* Eckl. & Zeyh., Enum. 224 (1836); Walpers in Linnaea 13: 512 (1839). Type: "in humidis (altit. III) laterum montis Duyvelsberg supra Geele Klee (Cap.)", *Ecklon & Zeyher* s.n. (Not seen).

P. pinnata L. var. *latifolia* Harv. in Harv. & Sond., Fl. Cap. 2: 144 (1862); Burtt Davy, Flow. Pl. Transv. 2: 375 (1932); Verdoorn in Flow. Pl. Afr. 26: 1029 (1947). Compton's (Fl. Swaziland 264, 1976) *P. pinnata* belongs to this taxon. Type: as for *P. arborea*.

P. affinis sensu Hutchinson, Bot. Mag. 136: t.8331 (1910).

Vernacular name: Natal - umHlonishwa (Zulu); tree psoralea.

asarina (Berg.) Salter in Jl. S. Afr. Bot. 5: 46 (1939); Salter in Adamson & Salter, Fl. Cape Penins. 490 (1950); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987).

Lens elatines folio singulari, minor pilosa, floribus luteis, e Madras-patan., auct. non Berg. (1767); Pluk. amalth. 131, t.454, f.8.

Crotalaria asarina Berg., Descr. pl. Cap. 194 (1767). *Hallia asarina* (Berg.) Thunb. in Schrad. Journ. 1: 322 (1799); Gen. nov. Pl. 11: 158 (1800); Fl. Cap. 594 (1823); DC., Prodr. 2: 123 (1825); Eckl. & Zeyh., Enum. 172 (1836); Harv. in Harv. & Sond., Fl. Cap. 2: 232 (1862). Type: **[Check for the type at the following herbaria SBT, S, LINN, UPS, and BOLO. Bergius's herbarium is probably the best place to start (*Auge* s.n.). Check folio 70. pl. 8.; Plukenet's herbarium is at BM. See Sloane books 83-85, 87-105. Check var. *burchellii* at Geneva.**

Hallia asarina (Berg.) Thunb. var. *burchellii* DC., Prodr. 2: 123 (1825). Type: South Africa, Camps Bay, 27 October 1810, *Burchell 371* (P, holotype; K, isotype). Dümmer (Trans. Roy. Soc. S. Afr. 7: 330, 1913) incorrectly referred *Lotononis wrightii* to this taxon. However, through the kindness of the Keeper, Trinity College, I have examined the type of *L. wrightii* and conclude that it is a species of *Argyrolobium*. A ceibachrome of the type is housed at K.

axillaris L.f., Suppl. 338 (1782); Poir. in Lam., Encycl. 5: 683 (1804); DC., Prodr. 2: 217 (1925); E. Mey., Comm. 83 (1836); Walpers, Repert. 1: 656 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 146 (1862); Forbes in Bothalia 3: 123 (1930); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987). The specimen cited by Eckl. & Zeyh. (Enum. 225, 1836) as this species belongs to *P. glaucina* Harv. **[Check the reference by Penther (2651) from Translkei. See axillaris file.**

linearis Thunb., Fl. Cap. 606 (1823) nom. illegit.; E. Mey. in Linnaea 7: 163 (1832); Eckl. & Zeyh., Enum. 225 (1836). **Check the identification of Burmann's species in Geneva, in Delessert's herbarium (G).**

Vernacular name: bloukeur.

azurea C.H. Stirton sp. nov. Type: Cape, N slopes of Outeniqua Mountains, upper slopes of Groot Doring river Catchment area next to forestry track, 12-11-1986, *Stirton, Zantovska & Vlok 11574* (NBG, holotype; K , PRE isotypes).

cataracta C.H. Stirton in Jl. S. Afr. Bot. 50,4: 462 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987).

Hallia filiformis Harv. in Harv. & Sond., Fl. Cap., 2: 232 (1836) non Poir (1804). Type: South Africa, Tulbagh Waterfall, *Pappe* s.n. (TCD, holotype).

crista C.H. Stirton sp. nov. Type: Cape, Cockscomb, Great Winterhoek Mountains, 2-2-1958, *Esterhuysen 27531* (PRE, holotype).

elegans C.H. Stirton sp. nov. Type: 2,5 km W turnoff to Gamkaskloof from Prince Albert to Swartberg Pass road, 11-11-1986, *Stirton, Zantovska & Vlok 11568* (NBG, holotype; K, STE isotypes).

ensifolia (Houtt.) Merrill in J. Arn. Arb. 19: (1938); Bond & Goldblatt, Pl. Cape Flora 296 (1984).

Anthylis ensifolia Houtt., Nat. Hist. II. 10: 120, t.62, f.3 (1799); Panzer, Pflanzensyst. 532, t.62, f.3 (1782). Type:

Psoralea capitata L.f., Suppl. 339 (1781); Thunb., Fl. Cap. 606 (1823); DC., Prodr. 2: 218 (1825); Eckl. & Zeyh., Enum. 227 (1836); E. Mey., Comm. 89 (1836); Harv. in Harv & Sond., Fl. Cap. 2: 151 (1862); Forbes in Bothalia 3: 120 (1930); Salter in Adamson & Salter, Fl. Cape Penins. 489 (1950); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987). *Lotodes capitatum* (L.f) O.K., Gen. Pl. 3,2: 65 (1891). Type: "Habitat ad Cap. bonae Spei, *Thunberg 433* (LINN 928.14 Lectotype; TCD, W isolectotypes).

Psoralea astragalina Poir. in Lam. Encycl. 4: 587 (1804). Type: **Check this species. Does it belong here? Check the spelling as Meyer refers to it as** *P. astragalifolia*.

Psoralea multicaulis Jacq., Hort. Schoenbr. 2: 55, t.230 (1797); DC., Prodr. 2: 217 (1925); G. Don, Gen. Syst. 2: 202 (1832); Eckl. & Zeyh., Enum. 2256 (1836). Type: " ex Promonotorio Bonae Spei, cultivated Herb Schoenbr.", Collector unknown.

What is Eckl. & Zeyh.'s *Psoralea multicaulis* **var.** *angustifolia* **from Van Stadensriver?**

fascicularis DC., Prodr. 2: 217 (1825); G. Don, Gen. Syst. 2: 201 (1832); Harv. in Harv. & Sond., Fl. Cap. 2: 146 ((1862); Forbes in Bothalia 3: 6 (1930); Salter in Adamson & Salter, Fl. Cape Penins. 488 (1950); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987) non sensu E. Mey., Comm. 83 (1836).

Lotus tenuifolius Burm., Cap. Prodr. 22 (1759) non L.

Psoralea tenuifolia Thunb., Fl. Cap. 606 (1823) non L. (1753). *P. thunbergiana* Eckl. & Zeyh., Enum. 225 (1836).

filifolia Eckl. & Zeyh., Enum. 227 (1836). Type: Cape, "in humidis (Altit. II) fruticem prope Waterfall in valle Tulbagh (Worcester)" (S, lectotype; L, MO, S, isotype).

fleta C.H. Stirton sp. nov. Type: Cape, Bainskloof Pass, 20-10-1986, *Stirton & Snijman 11226* (NBG holotype; K isotype).

glabra E. Mey., Comm. 83 (1836); Walpers, Repert. 1: 656 (1842). Type: "Witbergen, am Fuss der Berge, bei Rietvlei, Bamboeshoek, Bamboosspruit en Wilgerboschspruit", *Drège* s.n. (MO, Provisional Lectotype, S isolectotype). I have not yet seen any other Drège material of the other syntypes.

Psoralea pinnata L. var. *glabra* (E. Mey.) Harv. in Harv. & Sond., Fl. Cap. 2: 145 (1862).

glaucescensEckl. & Zeyh., Enum. 228 (1836). Lectotype: "in solo-ericeto (altit. IV) laterum montium in Onderbokkeveld", *Ecklon & Zeyher* s.n. (SAM, lectotype; K, L, MO, OXF, S, TCD, isotypes).

Psoralea oligophylla Eckl. & Zeyh. var. *glaucescens* (Eckl. & Zeyh.) Harv. in Harv. & Sond., Fl. Cap. 2: 146 (1862).

Psoralea facicularis DC. sensu E. Mey., Comm. 83 (1836).

glaucina Harv. in Harv. & Sond. Fl. Cap. 2: 147 (1862); Schinz in Bull. Herb. Boiss. 12: 997 (1902); Forbes in Bothalia 3: 124 (1930); Salter in Adamson & Salter, Fl. Cape Penins. 488 (1950); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Hall & Veldhuis, S. Afr. Red Data Book 85 (1985); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987). Type: sandhills at Doornhoogde, Cape District, *Ecklon* s.n.(S, holotype).

Vernacular name: blouteebossie.

gueinzii Harv. in Harv. & Sond. Fl. Cap. 2: 145 (1862); Duthie in Ann. Univ. Stellenbosch 6,3: 6 (1928); Forbes in Bothalia 3: 120 (1930); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987). Lectotype: without precise locality, *Gueinzius* s.n. (S, lectotype; TCD, isotype).

Hallia lanceolata Thunb., Mus. Upsal. append. 8: 131 (1800) nom. nud.

imbricata (L.f.) Salter in Jl. S. Afr. Bot. 5: 45 (1939); Salter in Adamson & Salter, Fl. Cap. Penins. 490 (1950); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987).

Hedysarum imbricatum L.f., Suppl. pl. 330 (1782); Syst. veg. ed. 13, 1122 (1791); Thunb. in Nov. Act. reg. Soc. Scient. Upps. 6: 42, t.1, f.2 (The drawing is based on *Thunberg 17163*, 1799); Gen. nov. Pl. 11: 158 (1800). Type: "C. B. S.", *Thunberg 353* **[Decide between LINN 9219.19 and Thunberg 17163, UPS]**

Hallia imbricata (L. f.) Thunb. in Schrad. Journ. 1: 322 (1799); Prodr. 130 (1800); Willd., Sp. Pl. 3: 1170 (1801); Pers. Synops. 2: 322 (1807); Hooker, Bot. Mag. 43: 1850 (1816); Loddiges, Bot. Cab. 4,9: 381 (1820); Reichb. Icon et Descrip. 1, f.2, t.10 (1821); Link, Enum. alt 2: 246 (1822); Sims, Bot. Mag. 52: 2586 (1825); DC., Prodr. 123 (1825): Eckl. & Zeyh., Enum. 172 (1836); E. Mey., Comm. 82 (1836); Harv. in Harv. & Sond., Fl. Cap. 2: 232 (1862).

Glycine monophylla auctt. non L. Jacquin's plate (Hort. Schoenbr. 2: 57, t.22, (1797) of this species belongs here.

imminens C.H. Stirton sp. nov. Type: Cape, Oudtshoorn, Rus-en-Vrede Waterfall, 11-11-1986, *Stirton & Zantovska 11564* (NBG, holotype; K, STE isotype).

implexa C.H. Stirton in Jl. S. Afr. Bot. 49: 329 (1983); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Cape, Delabat Ravine, NE ridge of Du Toits Kloof, *Esterhuysaen 33765* (NBG, holotype; BOL, K, NBG, PRE isotypes).

intonsa C.H. Stirton, sp. nov. Type: Cape, path between Jurie se Berg and Middelberg Hut, Cedarberg, 10-12-1982, *Taylor 10526* (STE, holotype; K, PRE isotype).

keeti Schonl. ex H.M.L. Forbes in Bothalia 3: 130 (1930); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Hall & Veldhuis, S. Afr. Red Data Book 85 (1985); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987). Type: Cape, Höeberg, *Keet 1055* (Pre, holotype; STE isotype).

laevigata L.f., Suppl. 339 (1782); Poir. in Lam., Encycl. 5: 691 (1804); DC., Prodr. 216 (1825); G. Don, Gen. Syst. 2: 201 (1832); Eckl. & Zeyh., Enum. 224 (1836). Type: "Habitat ad Cap. bonae Spei", *Thunberg* s.n. (****). **[This species may well be the smooth equivalent of *Psoralea verrucosa*. Could it be the same taxon as *Psoralea tenuifolia*].**

laxa Salter in Jl. S. Afr. Bot. 5: 46 (1939); Salter in Adamson & Salter, Fl. Cape Penins. 489 (1950); Kidd, Wild Flowers Cape Penins. t.21.3 (1972); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987).

Hallia virgata Thunb. in Schrad. Journ. 320 (1799); Gen. nov. Plant. 2: 157 (1800); Prodr. 131 (1800); Fl. Cap. 593 (1823); DC., Prodr. 2: 123 (1825); Eckl. & Zeyh., Enum. 173 (1836); Walpers in Linnaea 13: 511 (1839); Harv. in Harv. & Sond., Fl. Cap. 2: 232 (1862) non Nutt. (1818). Type: Not seen. **There does not appear to be a specimen in Herb. Thunb.**

Hallia angustifolia DC., Prodr. 2: 123 (1825); E. Mey., Comm. 82 (1836) non Jacquin (1797) nec Miller (1768). *Dorychnium angustifolium* Moench., Method 109 (1802). Type: South Africa, Cape Flats near Rondebosch, 14-12-1810, *Burchell 181* (P, holotype; K, isotype).

Hallia triquetra Burch. nom. nud.

monophylla (L.) C.H. Stirton in Jl. S. Afr. Bot. 50,4: 461 (1984); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987).

Glycine monophyllum L., Syst. nat. ed. 12, 2: 484 (1767); Mant. pl. 101 (1767); Mant. pl. Alt. Addim. 516 (1771); non Burm. 1768; auct. non L.: Jacq., Pl. Hort. Schoenbr. 2: 57, t.257 (1797). *Hallia monophylla* (L.) Schindler, fide Pfeiffer, Nom. 1: 1549 (1874). Type: "C.B.S.", collector unknown (LINN 901.20 lectotype).

Hedysarum cordatum Thunb. in Nov. Act. Reg. Soc. Sci. Upps. 6: 41 (1799); non Jacq (1800). Type: "Crescit in campis graminosis ultra Swellendam, C.B.S", *Thunberg* s.n. (UPS, specimen *17161* lectotype). Nomenclaturally superfluous name. *Hallia cordatum* (Thunb.) Thunb. in Schrad. Journ. 1: 321 (1799); Gen. nov. Pl. 11: 158 (1800); Prodr. 131 (1800); W.T. Aiton, Hortus Kew. 4: 338 (1812); Thunb., Fl. Cap. 593 (1823); DC., Prodr.: 123 (1825); Eckl. & Zeyh., Enum. 172 (1836); E. Mey., Comm. 82 (1836). *Psoralea cordata* (L.) Salter in Adamson & Salter, Fl. Cape Penins. 490 (1950). Salter transferred this species from *Hallia* to *Psoralea* but the basionym *Hedysarum cordatum* L. does not exist.

Hedysarum sagittatum Poir. in Lam., Encycl. 6: 403 (1804). *Hallia saggitata* (Poir.) Desv. in Ann. Sci. Sèr.: 408 (1826). *Desmodium saggitatum* (Poir.) DC., Prodr. 2: 326 (1825). Type not seen.

The illustration labelled *Psoralea asarina* in Kidd, Wild Flowers Cape Penins. t.4.2 (1973), belongs here.

muirii C.H. Stirton, sp. nov. Type: Cape, Aaasvogelberg, 11-1914, *Muir 1850* (PRE, holotype; BOL isotype).

nubicola C.H. Stirton, sp. nov. Type: Cape, Grootberg Mountain, Lemoenshoek, above Grootvadersbos, 6-12-1981, *Stirton 10212* (NBG, holotype).

odoratissima Jacq., Pl. Hort. Schonbr. 2: 54, t.229 (1797); Dietrich, Lex. Gart. Bot. 7: 611 (1807); DC., Prodr. 2: 216 (1923); G. Don, Gen. Syst. 2: 201 (1832); Walpers in Linnaea 13: 512 (1839); Reichb., Ic. Pl. Descrip. 97, t.2 (****); Harv. in Harv. & Sond., Fl. Cap. 2: 144 (1862); Forbes in Bothalia 3: 124 (1930); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Hall & Veldhuis, S. Afr. Red Data Book 85 (1985). Type:

oligophylla Eckl. & Zeyh., Enum. 227 (1836); Walpers, Repert. 1: 656 (1842); Harv. in Harv. & Sond., Fl. Cap. 146 (1862); Forbes in Bothalia 3: 121 (1930); Gledhill, E. Cape Veld Flowers 133, t.30.10 (1981); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987). Type: "In humidis (Altit. II) ad rivulos laterum montium Zwartehoogdens inter Grahamstown et Hassagaybosch (Albany)", *Ecklon & Zeyher* s.n. (S, lectotype; S, isolectotypes).

Vernacular name: bloukeur, swartstorm.

oreophila Schltr. in Engl., Bot. Jahrb. 24: 442 (1897); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987). Type: Cape , Sir Lowry's Pass, 4-1-1896, *Schlechter 7233* (SAM 49217: **holotype uncertain. Needs further investigation. This species might comprise two distinct taxa. The northern Sneeukop plants are more robust with larger flowers whereas the Sir Lowry's Pass plants are more slender with smaller flowers and shorter calyces. Check also the cupulum.**

oreopola C.H. Stirton, sp. nov. Type: Cape, Middelberg Pass, Kleinfontein Extension, Elandskloof, 5-11-1986, *Stirton, Zantovska, Bean & Viviers 11488* (NBG, holotype; K isotype).

peratica C.H. Stirton sp. nov. Type: Cape, Piketberg Mountains, Goedverwacht, 23-9-1981, *Stirton, Zantovska & Cribb 9324* (PRE, holotype; K isotype).

pinnata L., Pl. rar. Afr. 15 (1760); Sp. Pl. 2: 1074 (1762); Berg., Descr. pl. Cap. 218 (1767); Mant. 225 (1767); Burm. f., Cap. 22 (1759); Willd., Sp. Pl. 3: 1342 (check date); Ait., Hort. Kew , ed. 2, 4: 374 (1789****); Thunb., Prodr. 136 (1800); Thunb., Fl. Cap. 609 (1823); Link, Enum. 2: 257 (1822); Sweet, Hort. brit. 170 (1826); Poir. in Lam., Encycl. 5: 690 (1804); Dietrich, Lex. Gart. Bot. 7: 612 (1807); DC., Prodr. 2: 216 (1825); E. Mey. in Linnaea 7: 163 (1832); Eckl. & Zeyh., Enum. 224 (1836); E. Mey., Comm. 82 (1836); Richter, Codex 739 (1840); Walpers, Repert. 1: 655 (1842); Reichenb., Ic. Descrip. Pl. t.97, f.1 (1823); Harv. in Harv. & Sond., 2: 144 (1862); Bews, Introdt. Fl. Natal Zulu. (1921); Forbes in Bothalia 3: 125 (1930); Salter in Adamson & Salter, Fl. Cape Penins. 485 (1950); Kidd, Wild Flowers Cape Penins. t.81.12 (1972); Moll, Trees Natal 485 (1981); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987). *Ruteria pinnata* (L.) Moench., Method. 115 (1794). *Lotodes pinnatum* (L.) O.K., Gen. Pl. 3,2: 65 (1898). Type: Collector unknown (Hort. Cliff. 370.1, lectotype).

Psoralea foliis pinnatis, linearibus floribus axillaribus. Hort. Ups. 225 (1745); Kniph., Bot. Orig. Centaur 12 (1764).

Psoralea foliis pinnatis, foliolis linearibus, acuminatis. Roy., Fl. leyd. prodr 373.

Dorychnium caule fruticoso, foliis pinnatis, foliolis linearibus. Hort. Cliff. 370 (1737).

Spartium africanum. Riv., tetra. 11 (1691).

Genista affinis arbor africana, monospermos, flore caeruleo, foliis pinnatis. Herm., Hort. lugd.-bat. cat. 272, t.273 (1687).

Genista spartium caeruleum, africanum, foliis pinnatis. Breyn., Prodr. rar. pl. 1: 36 (1680).

Genista, chamaegenista, africana, frutescens, flore caeruleo. Tit., cat. Maurocen. 77 (1713).

Genista affinis africa, flore caeruleo, alatis et punctatis foliis, asperiusculus. Ten Rhyn. Fasc. 24.

Barba jovis africana, foliis viridibus pinnatis, flore coeruleo. Boerhaave, Ind. alter hort. Lugd.-Bat. 2: 40 (1720).

Psoralea decidua Sieb., nom. nud., sensu auctt., non Bergius (1767).

R. africana Medic., 380 (1787) nom. illegit.

Psoralea conferta Bertol., Horti bonon. pl. nov. 2: 17, t.II.2 (1839). Type: Cultivated from seed received by Bertoloni from the Royal Botanical Garden at Wirtenburg. *Bosch* s.n. (BOLO, holotype).

Psoralea altissima Bertol., Horti bonon. pl. nov. 2: 16, t.II.1(1839). Type: Cultivated from seed received by Bertoloni from the Royal Botanical Garden at Wirtenburg. *Bosch* s.n. (BOLO, holotype).

Psoralea pinnata L. var. *glabriuscula* Eckl. & Zeyh., Enum. 224 (1836). Type: "prope Swellendam", *Mund* s.n. **What is this taxon? I have not seen any herbarium material of this species.**

Vernacular name: fonteinbos, bloukeur, penwortel, fountain bush, pinnate-leaved psoralea.

There is a photograph of a painting by Burchell of this species in Pitman & Palmer, Trees S. Afr. 2: 920 (1972).

plauta C.H. Stirton in Jl. S. Afr. Bot. 50,4; 462 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987), as "*P. planta*".

Hallia flaccida Thunb. in Schrad. Journ. 319 (1799); Prodr. 131 (1800); W.T. Aiton, Hortus Kew. 4: 338 (1812); Thunb., Fl. Cap. 593 (1823); DC., Prodr. 2: 123 (1825); Eckl. & Zeyh., Enum. 172 (1836). Type: "e Cap. Bon. Spei", *Thunberg* s.n. (UPS, Thunberg Herb. 17162), non Nâbelèk (1923).

pullata C.H. Stirton sp. nov. Type: Cape, Vogelgat Private Nature Reserve, 15-10-1986, *Stirton & Williams 11179* (NBG holotype; K isotype).

repens Berg., Descr. pl. Cap. 223 (1767); L., Mant. pl. alt. 265 (1771); Thunb., Fl. Cap. 607 (1823); DC., Prodr. 217 (1825); E. Mey. in Linnaea 7: 166 (1832); G. Don, Gen. Syst. 2: 202 (1832); Eckl. & Zeyh., Enum. 225 (1836); E. Mey., Comm. 84 (1836); Richter, Codex 740 (1840); Walpers, Repert. 1:656 (1842); Harv. in Harv. & Sond., Fl. Cap., 2: 149 (1862); Forbes in Bothalia 3: 126 (1930); Salter in Adamson & Salter, Fl. Cap. Penins. 488 (1950); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987). Type:

Psoralea diffusa Eckl. & Zeyh., Enum. 225 (1836). Type: "In collibus arenosis ad litus sinus Algoabay prope Cap Recief", *Ecklon & Zeyher*, s.n. (S, lectotype; K, SAM, STE, TCD, isolectotypes).

restioides Eckl. & Zeyh., Enum. 227 (1836); Walpers, Repert. 1: 658 (1842); Harv. in Harv. & Sond., Fl. Cap. 2; 146 (1862); Salter in Adamson & Salter, Fl. Cape Penins. 489 (1950); Forbes in Bothalia 3: 119 (1930); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Bohnen, Flow. Pl. S. Cape 32, t.42.1 (1986); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987). Type: "In humidis (altit. II) laterum montium Klynriviersberge (Caledon)", *Ecklon & Zeyher* s.n. (S, lectotype; E, K, S, TCD, isolectotypes).

rhizotoma C.H. Stirton sp nov. Type. Cape, Transkei, Mhlahlani Forest reserve, 24-1-1986, *Stirton 11140* (K holotype).

rigidula C.H. Stirton sp. nov. Type: Cape, NE ridge of Du Toits Peak, above Delabat Ravine, 7-2-1975, *Esterhuysen 33766* (BOL, holotype; K, NBG isotypes).

sordida C.H. Stirton sp. nov. Type: Cape, Swartberg pass, 11-11-1986, *Stirton, Zantovska & Vlok 11572* (NBG, holotype; K, isotype).

speciosa Eckl. & Zeyh., Enum. 224 (1836); Walpers, Repert. 1: 656 (1842). Type: " Inter frutices (altit. II) ad Keureboomrivier prope Langekloof (Georg.)", *Ecklon & Zeyher* s.n. (S lectotype; S isolectotype).

tenuissima E. Mey., Comm. 84 (1836); Walp., Repert. 1: 656 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 147 (1862); Forbes in Bothalia 3: 124 (1930); Bond & Goldblatt, Pl. Cape Flora 296 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987). Lectotype: "Dutoitskloof, in montosos asperis, alt. 2500-3000 ped (III.A.e)" (K, lectotype; E, GBH, K, MO, OXF, P, PRE, TCD, isolectotype).

triflora Thunb., Fl. Cap. 606 (1823); G. Don, Gen. Syst. 2: 201 (1832); DC., Prodr. 217 (1823); Eckl. & Zeyh., Enum. 606 (1836) non Poir (1804). Type: **I am not sure about the application of this name.**

trullata C.H. Stirton in Jl. S. Afr. Bot. 49: 332 (1984); Bond & Goldblatt, Pl. Cape Flora 297 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987). Type: Cape, Blaauboschbaai, *Fourcade 2827* (PRE, holotype; STE, isotype).

verrucosa Willd., Sp. Pl. 3: 1343 (1764); W.T. Aiton, Hort. Kew., ed. 2, 4: 374 (1789); Pers., Syn. 2: 346 (1806); Poir. in Lam., Encycl. 5: 683 (1804); Dietrich, Lex. Gart. bot. 7: 614 (1807); DC., Prodr. 2: 216 (1825); G. Don, Gen. Syst. 2: 201 (1832); E. Mey., Comm. 83 (1836); Eckl. & Zeyh., Enum. 225 (1836); Forbes in Bothalia 3: 121 (1930). Bond & Goldblatt, Pl. Cape Flora 297 (1984); Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987). Type: (Herb. Willdenow 14135).

> *Psoralea tenuifolia* L., Sp. Pl. 542 (1752); Sp. Pl. 2: 1074 (1762); Mant. 2: 450 (1771); Thunb., Prodr. 135 (1823); Poir. in Lam., Encycl. 5: 682 (1804); DC., Prodr. 2: 217 (1823); E. Mey., Comm. 83 (1836); Eckl. & Zeyh., Enum. 225 (1836); Richter, Codex 740 (1840); Walpers in Linnaea 13: 513 (1839); Walpers, Repert. 1: 513, 656 (1842); Reich., Ic. Descrip. Pl. t.30.1 (1823). *Ruteria tenuifolia* (L.) Moench, Method. suppl. 38 (1794).
>
> *Psoralea angustifolia* Jacq., Pl. Hort. Schoenbr. 2: t.226 (1797) non Miller (1768).
>
> *Psoralea intermedia* Bess., Cat. hort. cremeneci 111 (1816). **[check the origin of this name. Is it a nom. nud.?**
>
> *Psoralea verrucosa* Willd. var. *intermedia* DC., Prodr. 2: 216 (1823). **[What is this name?]**
>
> Vernacular name: bloukeur.

vlokii C.H. Stirton sp. nov. Type: Cape, upper reaches of Groot Doringsbosrivier, north slopes of Outeniqua Mountains, 12-11-1986, *Stirton, Zantovska & Vlok 11582* (NBG holotype, K isotype).

Rejected names

Hallia hirta Willd. = *Crotalaria hebecarpa* (DC.) Rudd

Psoralea biovulata H. Bolus = *Amphithalea biovulata* (H. Bolus) Granby

Psoralea cytisoides L. (Sp. Pl., ed.2,1: 1076, 1763; Burm. f., Prodr. Fl. Cap.: 22, 1768). Lectotype: See D.O. Wijnands (The Botany of the Commelins, p. 163. Balkema, Rotterdam, 1983). [LINN 923.13, *Van Rooyen* s.n., sent in 1759]) = *Indigofera cytisioides* (L.) L.

Psoralea frutescens Poir. = *Bituminaria bituminosa* (L.) C.H. Stirton

Psorlea involucrata Thunb. = *Melolobium involucratum* (Thunb.) C.H. Stirton

Psoralea linearis Burm.f. = *Aspalathus linearis* (Burm.f) R. Dahlgr.

Psoralea prostrata L. = *Rhynchosia ferulaefolia* (Presl.) Benth.

Psoralea tetragonoloba L'Herit. = *Dolichos L'Herit.*

Lotononis wrightii Dümmer (Trans. Roy. Soc. S. Afr. 7: 330, 1913) = *Argyrolobium* sp., non *Hallia asarina* Thunb. fide Dümmer (1913).

Imperfectly known

Psoralea astragalifolia Poir. in Lam., Encycl. 4: 587 (1804); DC., Prodr. 2: 218 (1823). Type: (P, holotype). **Check the identity of this on the Paris trip.**

Psoralea kraussiana Meisn. in Hook., Lond. J. Bot. 2: 81 (1843); Walpers, Repert 2: 856 (1843). Type: "In solo argillaceo ad latus australe montes Tafelberg, III.A.e., *Krauss* s.n. **(Specimens not yet located. Try NY).**

Psoralea punctata Desv. in Ann. Sci. nat., Ser. 9: 411 (1826); Walpers, Repert 1: 658 (1842). Type: not yet located.

Psoralea velutina E. Mey., Comm. 89 (1836). Type: "Sub montibus Swartbergen, in depressis humidiusculis, prope Klaarstroom, Altit. 2000 ped. II.e." *Drège* s.n. Type: not yet located.

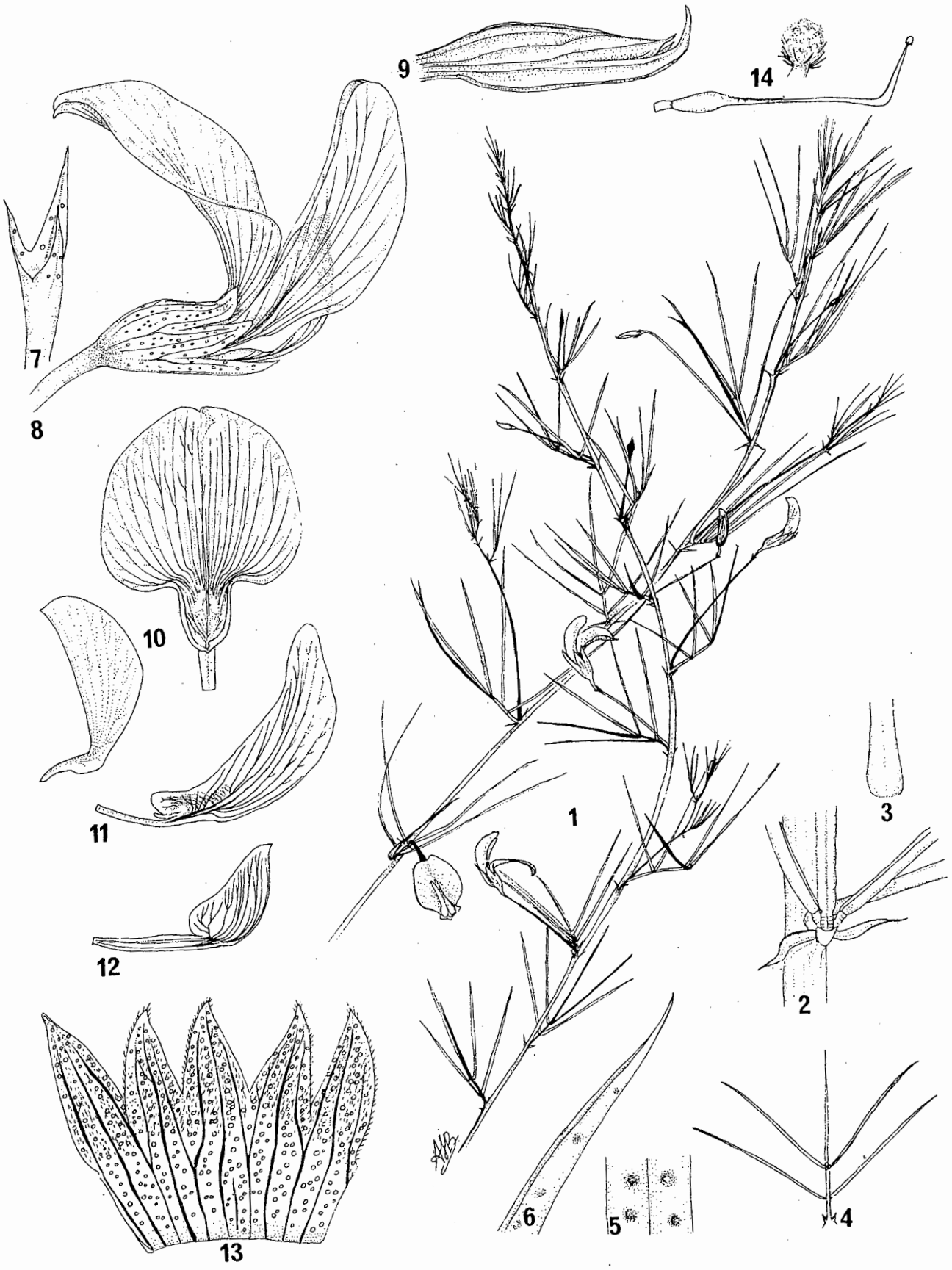
Hallia sororia Willd., Pers, Syn. Pl. 2: 318 (1807) = *Glycine monophyllos* Burm.f. (ind. 161, t.50, f.2) fide Persoon and = *Eleiotes sororia* DC. fide Wight & Arn., fl. Penins Ind. or. 1: 231.

Rafnia angulata Thunb. var. *filifolia* . See E, Mey., Comm. 13 (1836). The specimen in Leiden is a *Psoralea*.

APPENDIX 2

Black and white illustrations of undescribed and little known species of *Psoralea*.

Psoralea abbottii C.H. Stirton
Psoralea azurea C.H. Stirton
Psoralea crista C.H. Stirton
Psoralea ensifolia (Houttyn) Merrill
Psoralea filifolia Eckl. & Zeyh.
Psoralea fleta C.H. Stirton
Psoralea imminens C.H. Stirton
Psoralea implexa C.H. Stirton
Psoralea latifolia (Harv.) C.H. Stirton
Psoralea muirii C.H. Stirton
Psoralea nubicola C.H. Stirton
Psoralea oreophila C.H. Stirton
Psoralea oreopola C.H. Stirton
Psoralea peratica C.H. Stirton
Psoralea pullata C.H. Stirton
Psoralea repens Berg.
Psoralea restioides Eckl. & Zeyh.
Psoralea rhizotoma C.H. Stirton
Psoralea rigidula C.H. Stirton
Psoralea sordida C.H. Stirton
Psoralea speciosa Eckl. & Zeyh.
Psoralea tenuissima E. Mey.
Psoralea trullata C.H. Stirton
Psoralea verrucosa Willd.
Psoralea vlokii C.H. Stirton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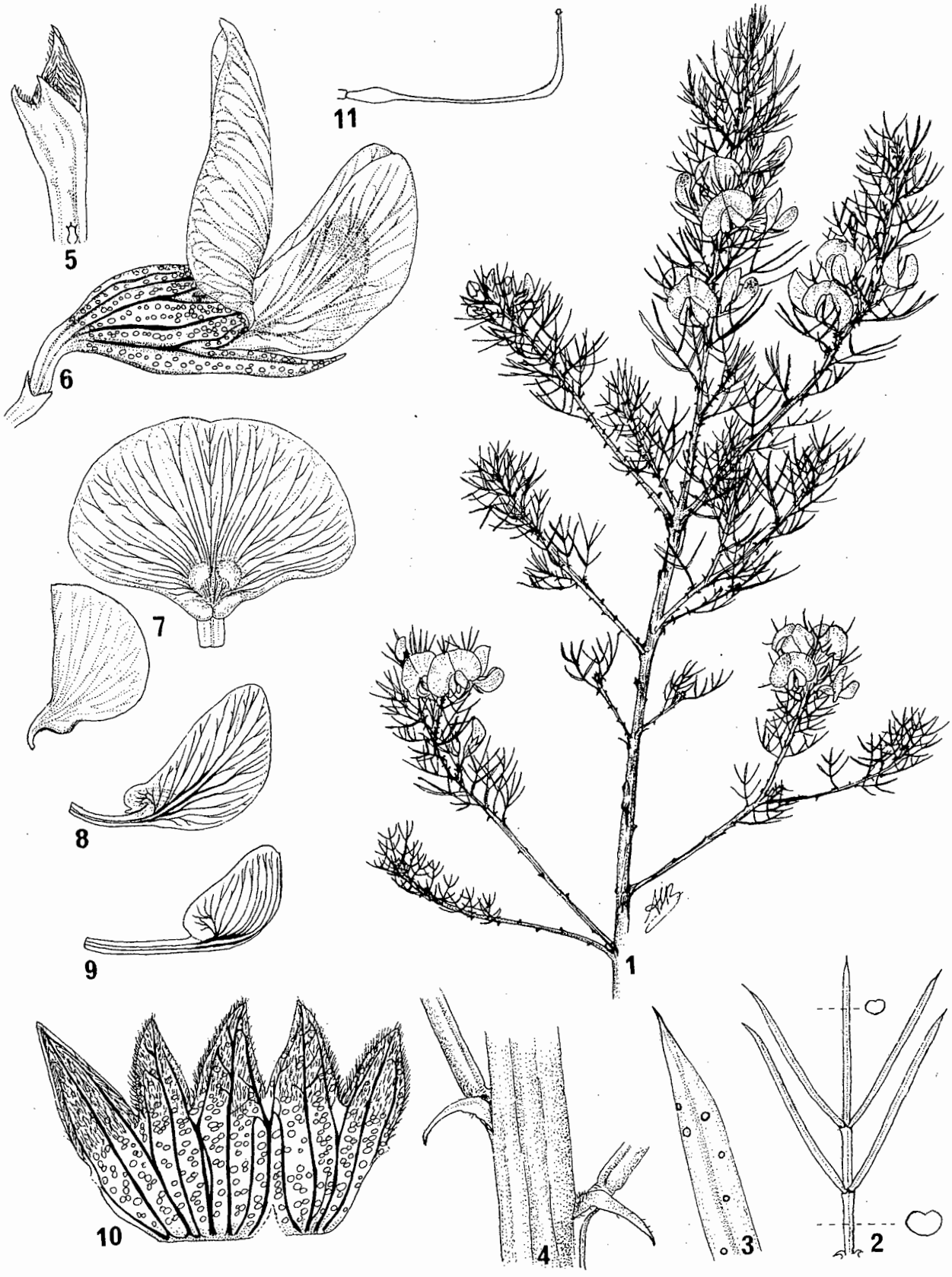
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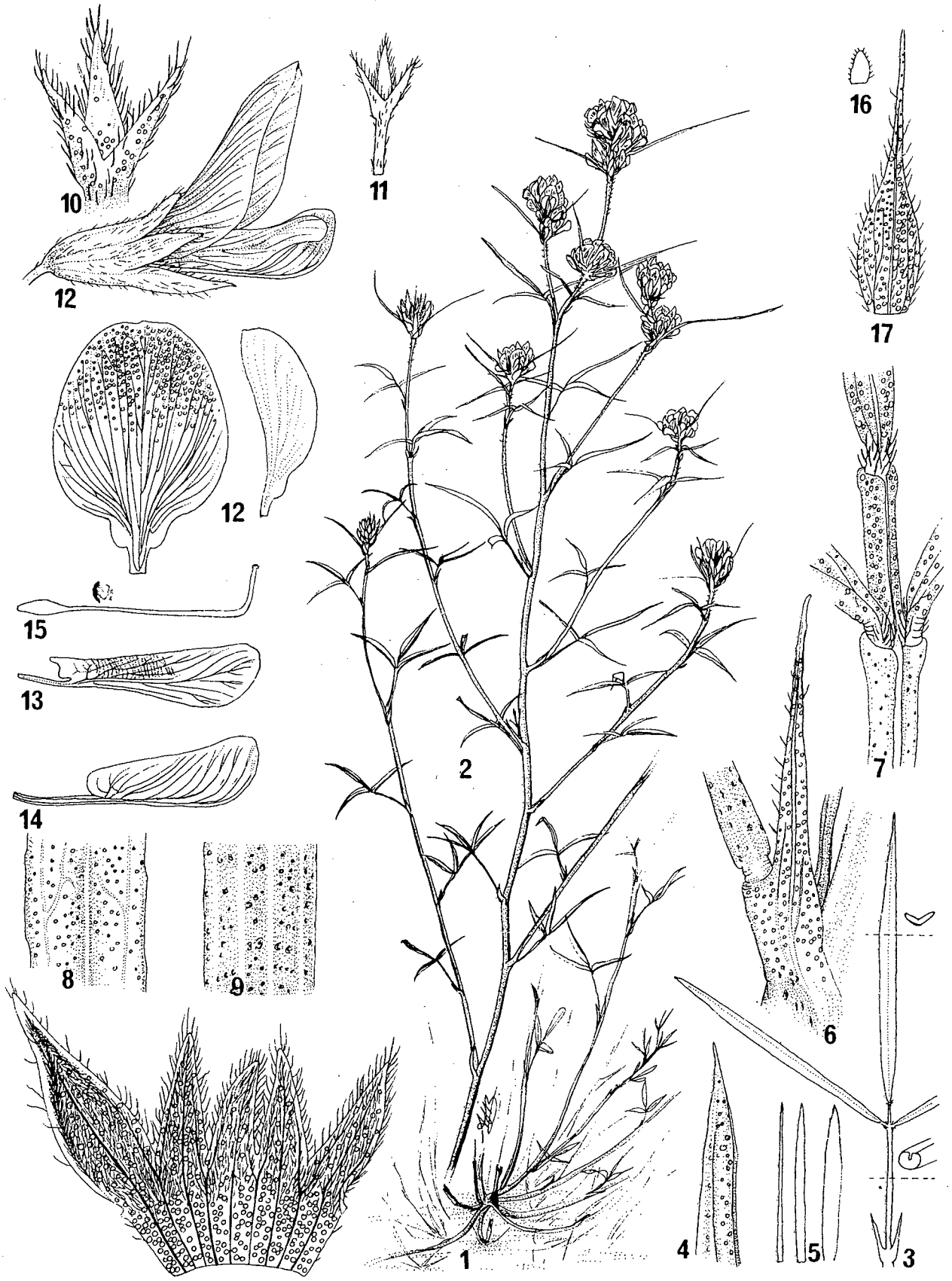
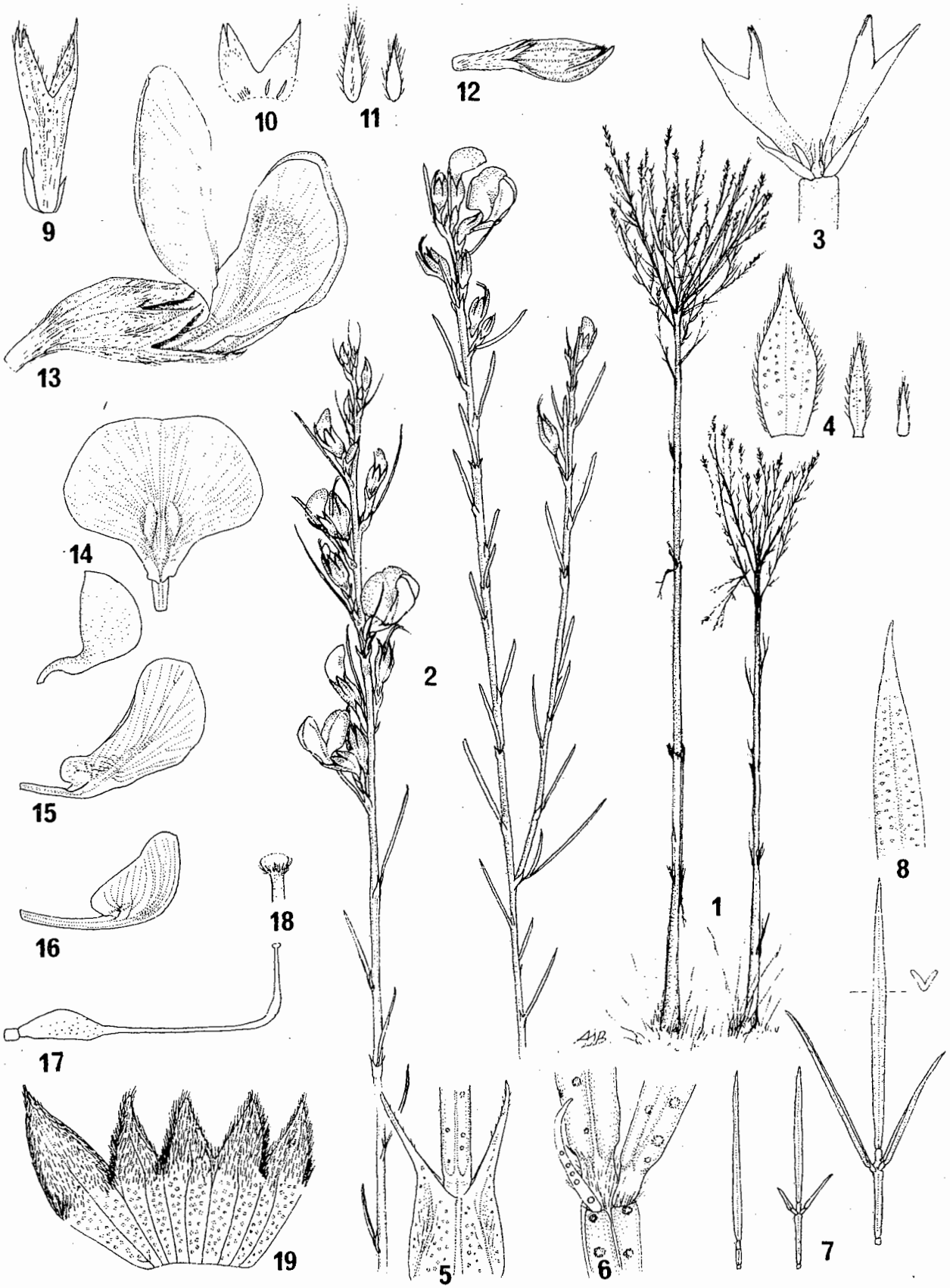
Psoralea ensifolia (Houttyn) Merrill

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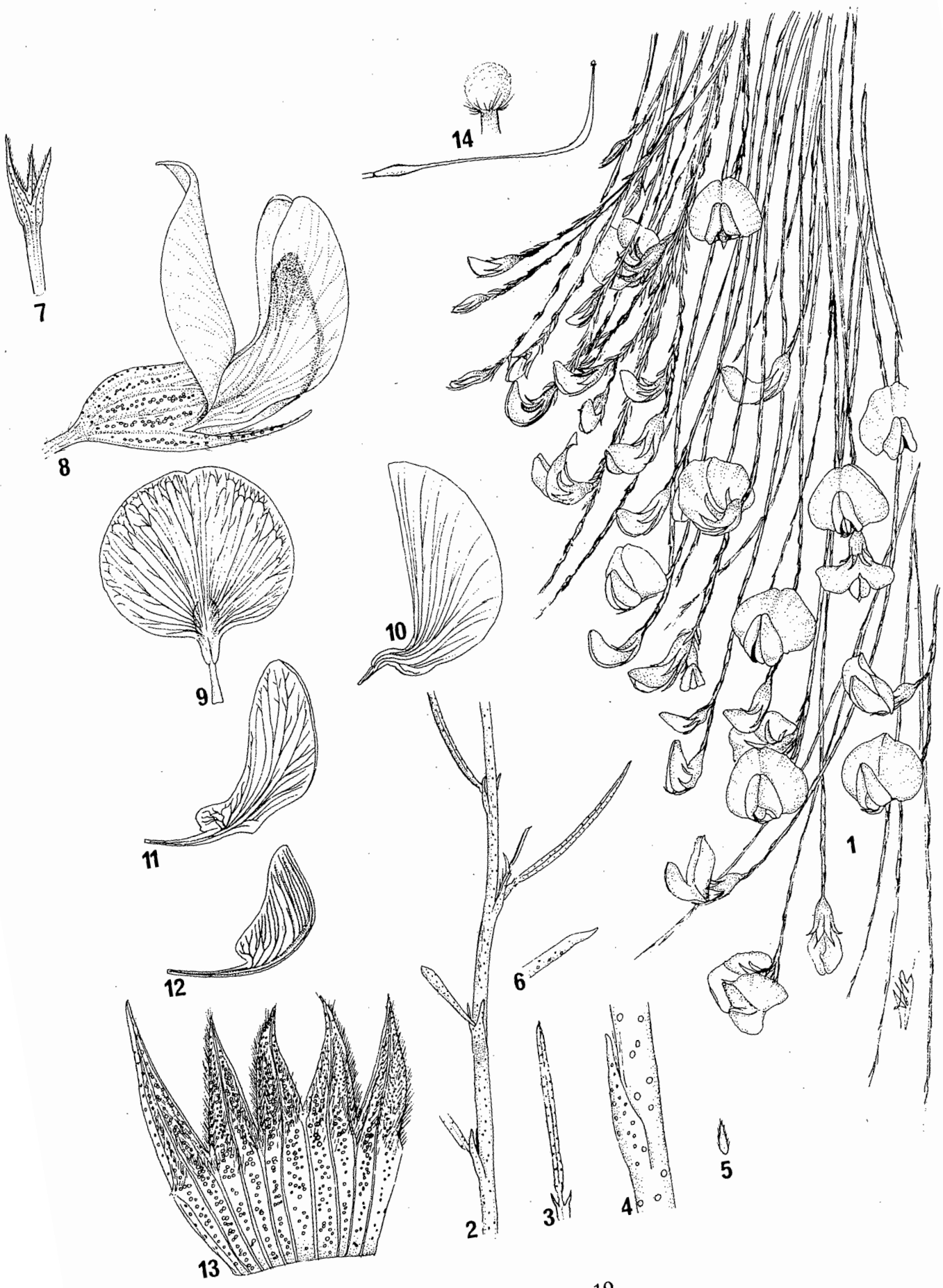
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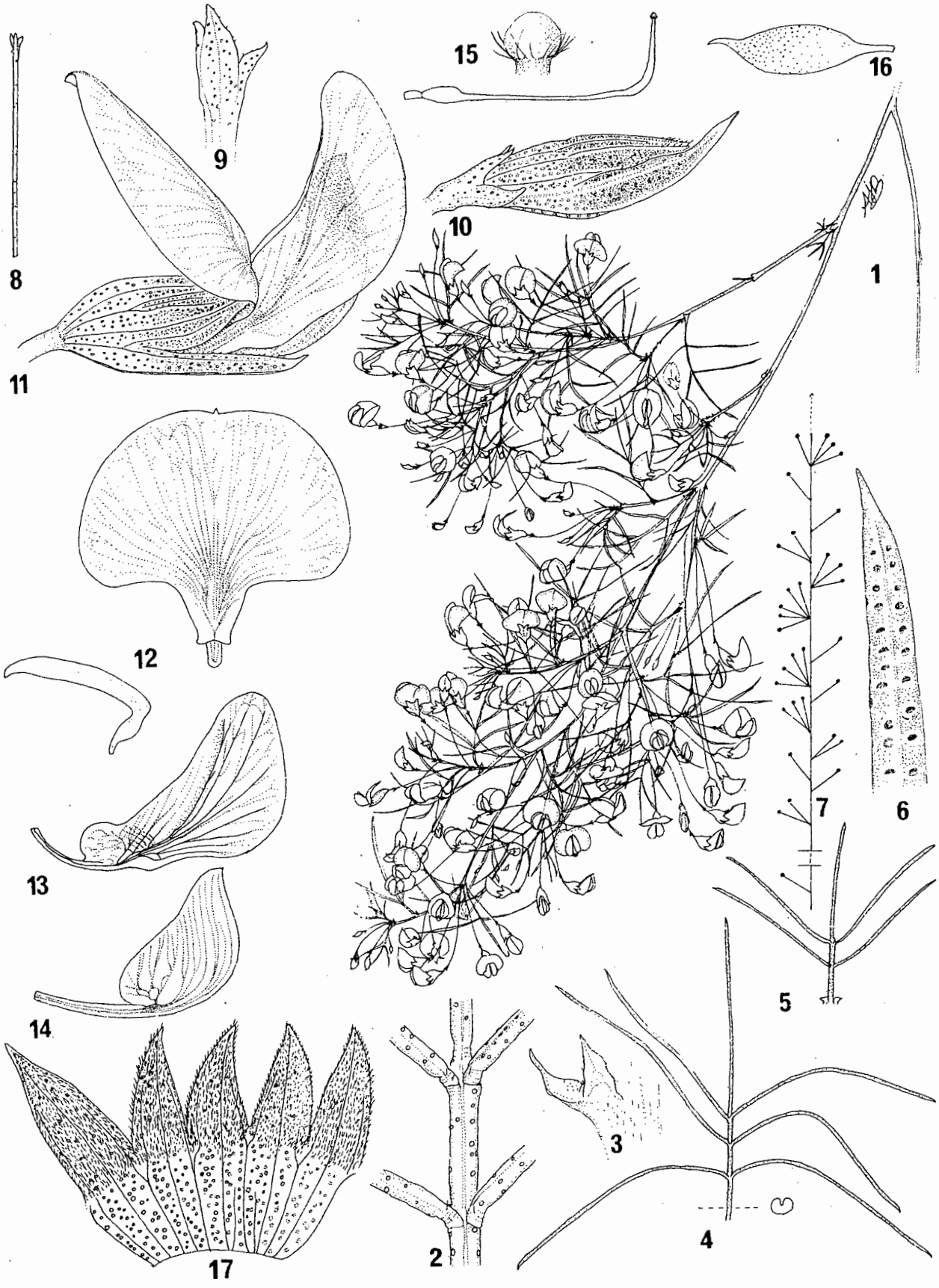
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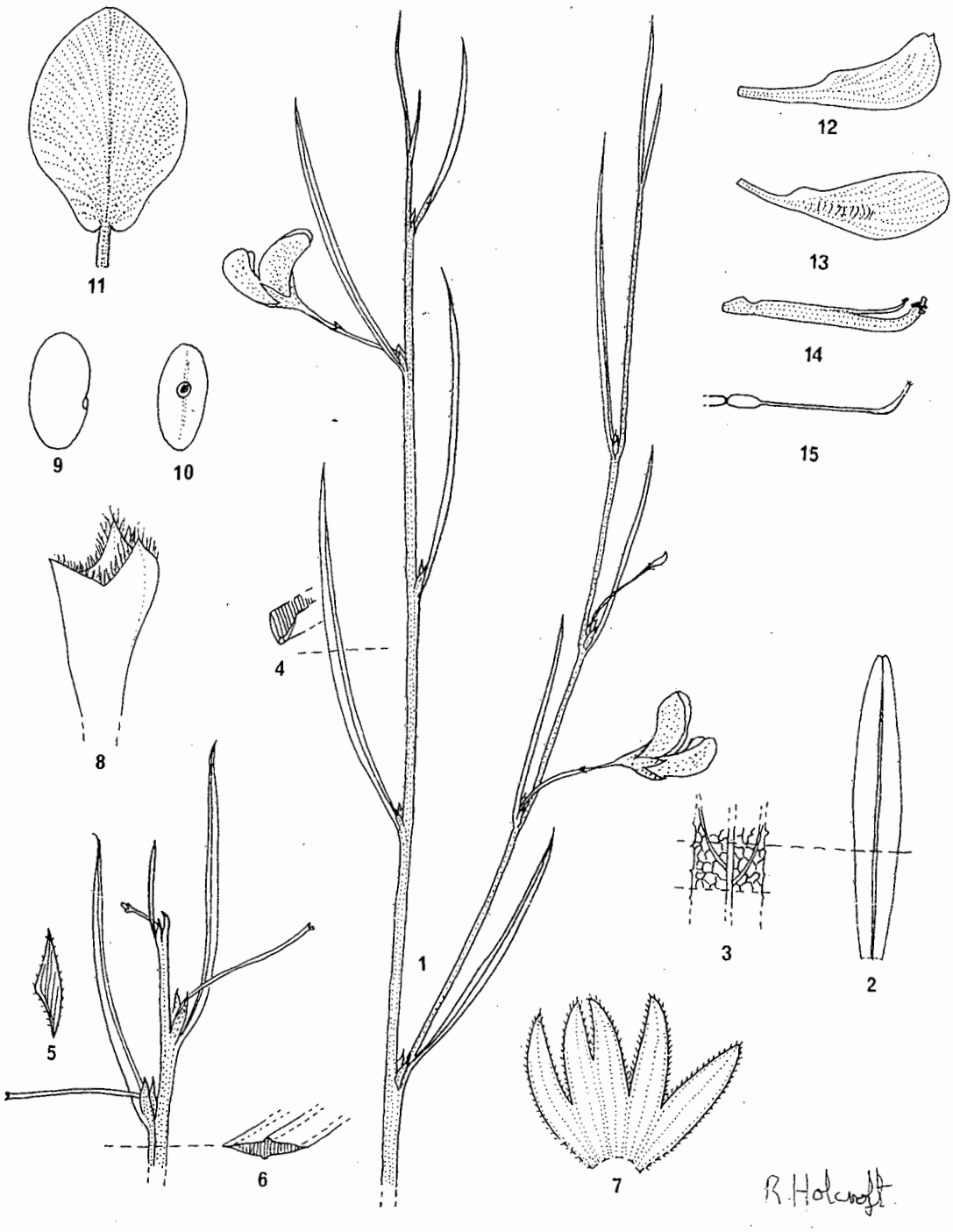
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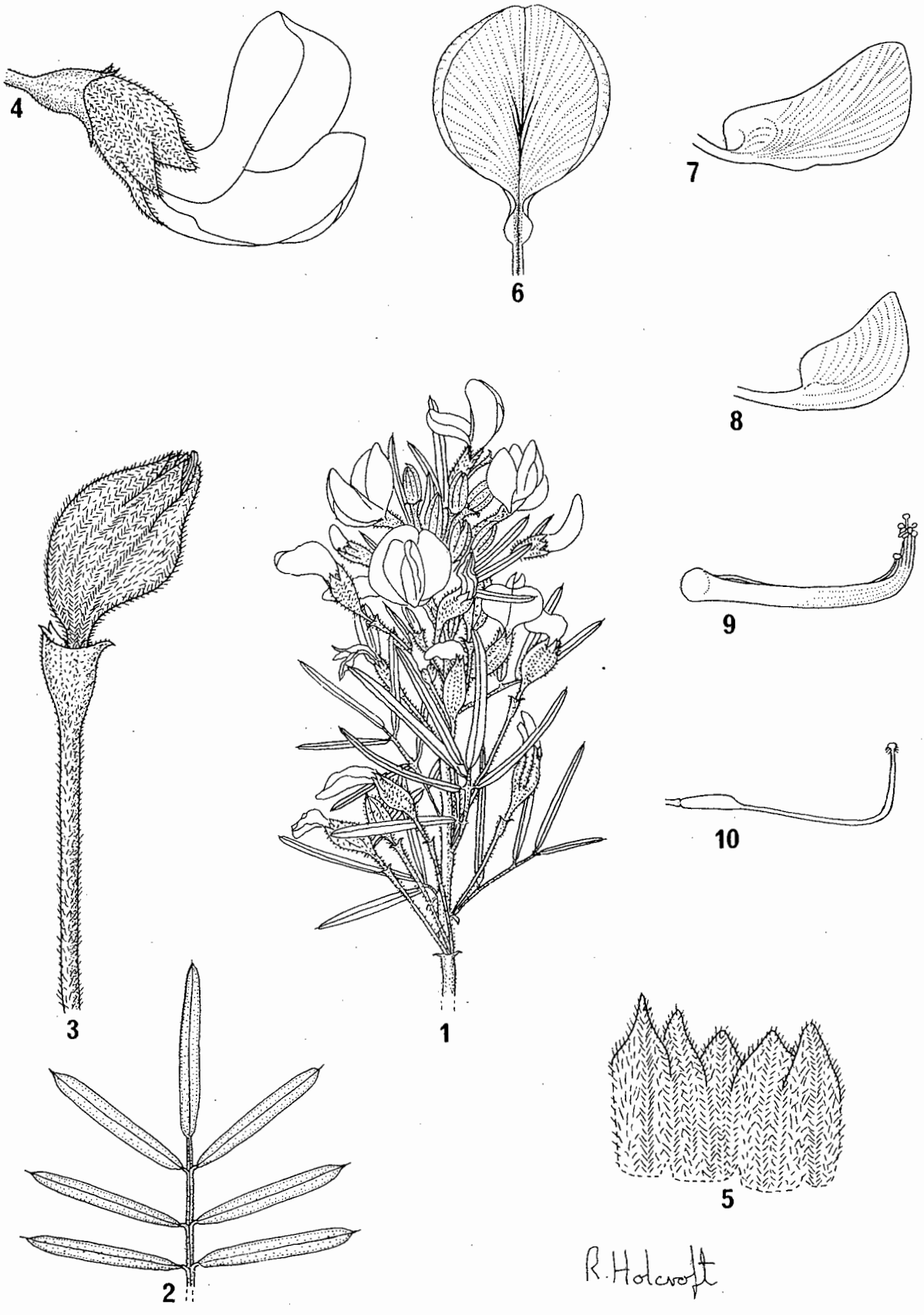
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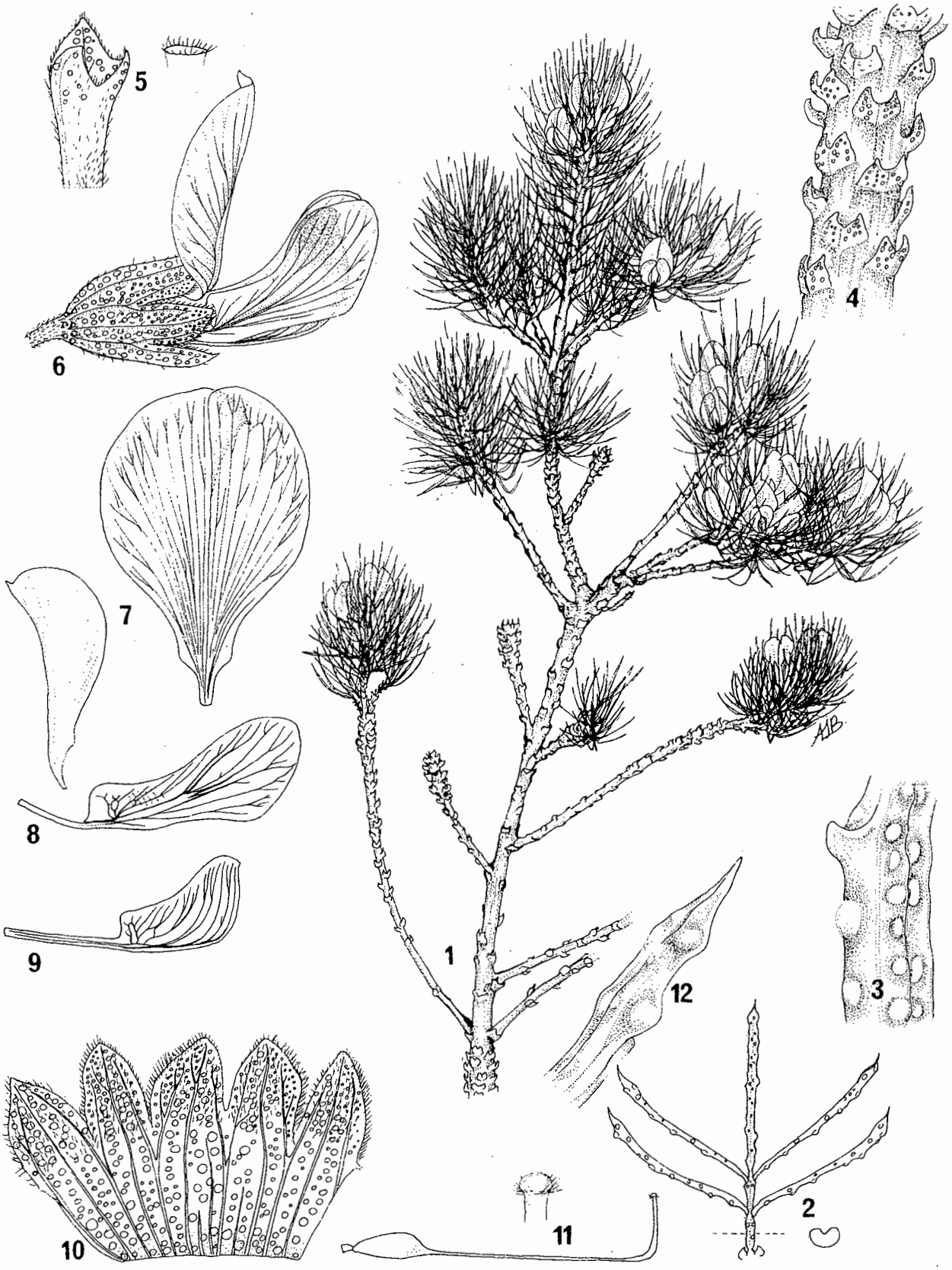
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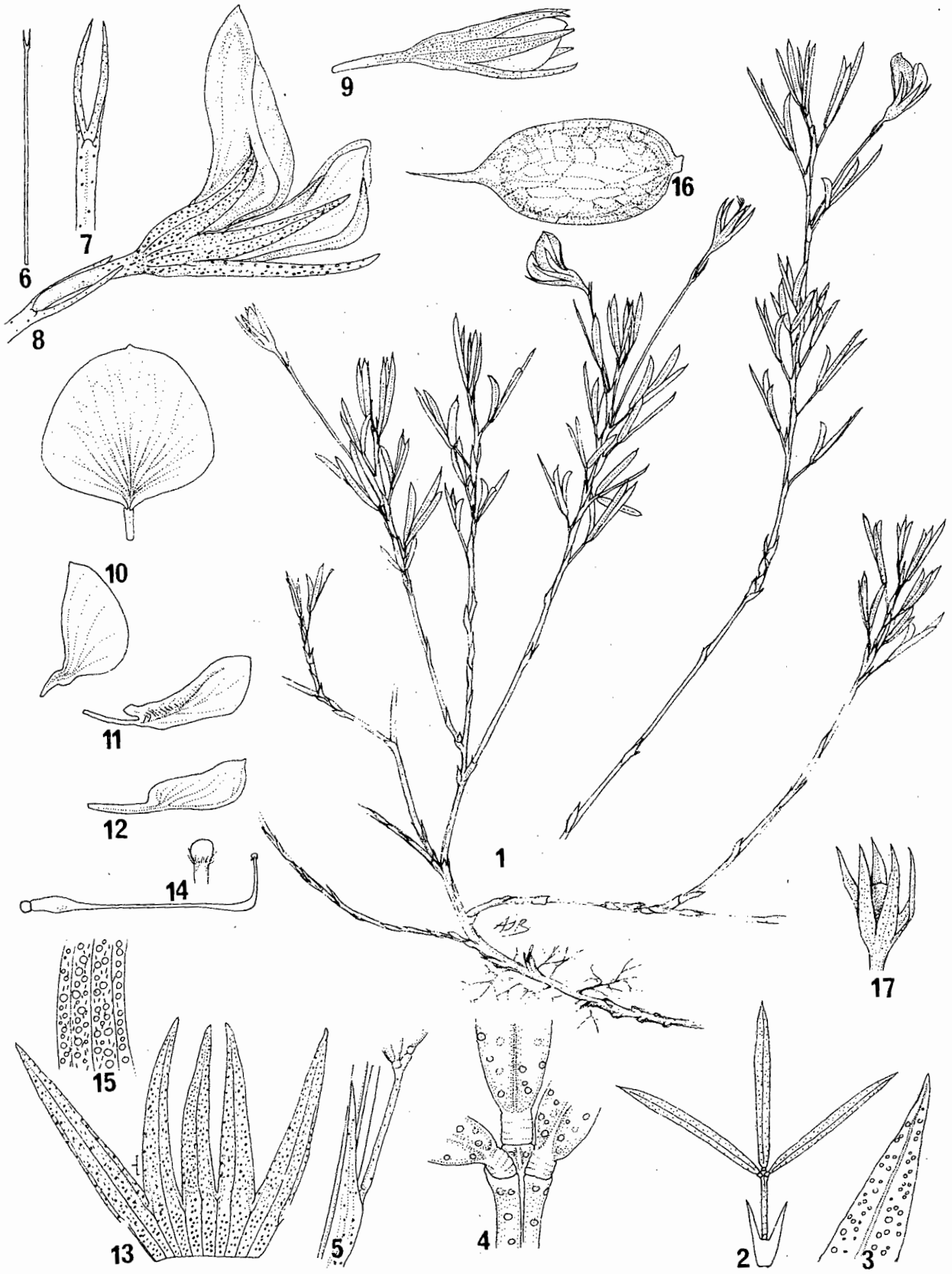
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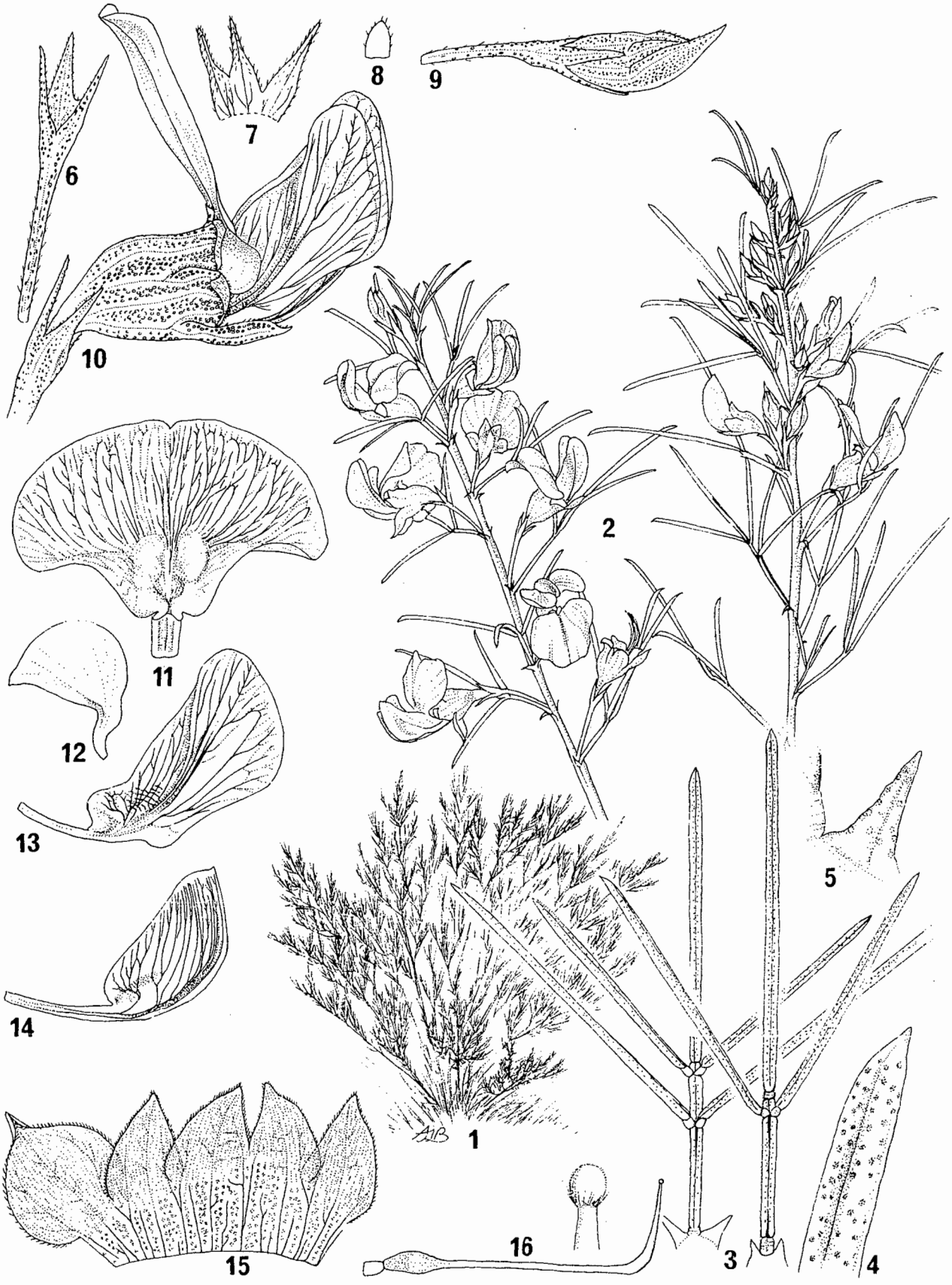
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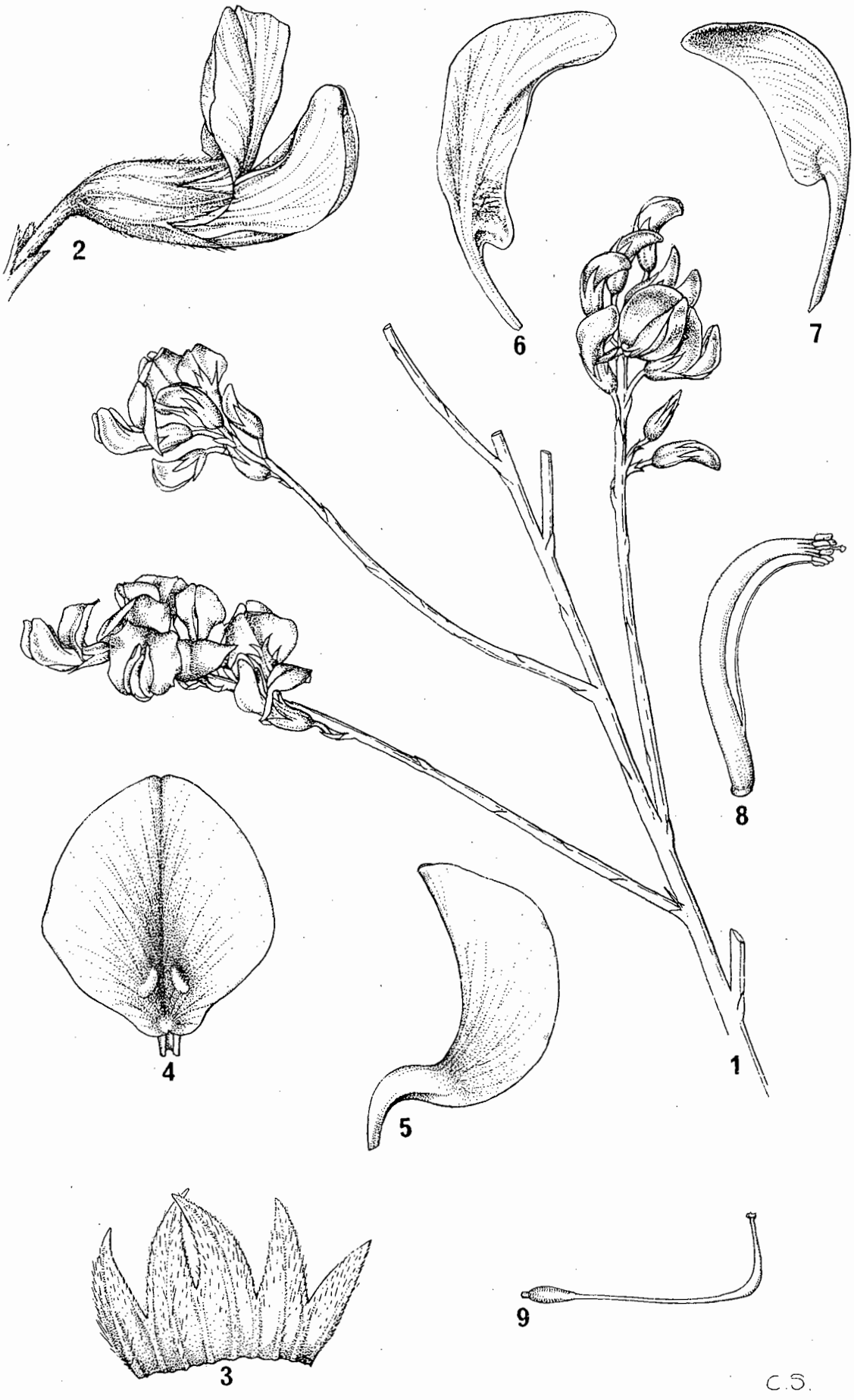
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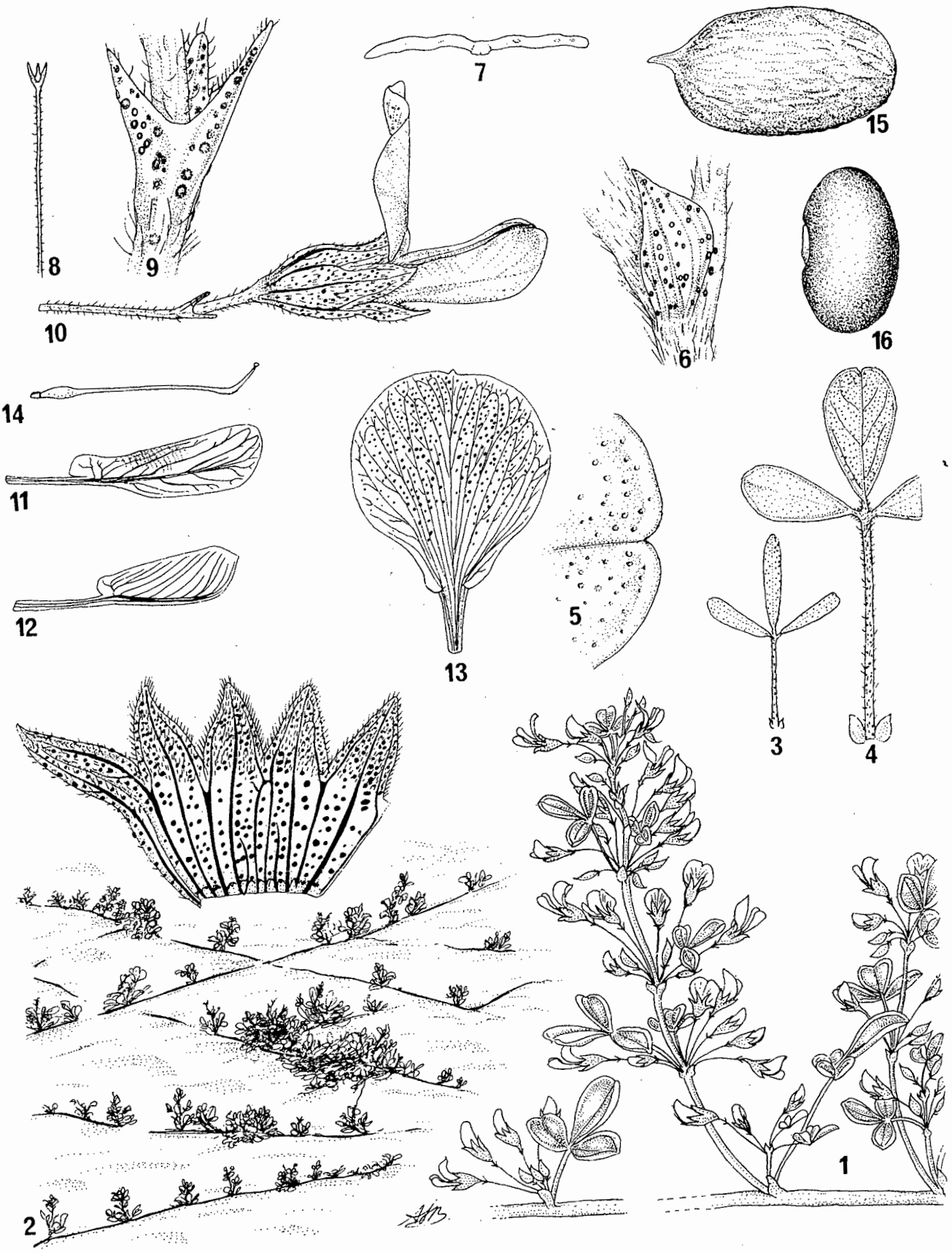
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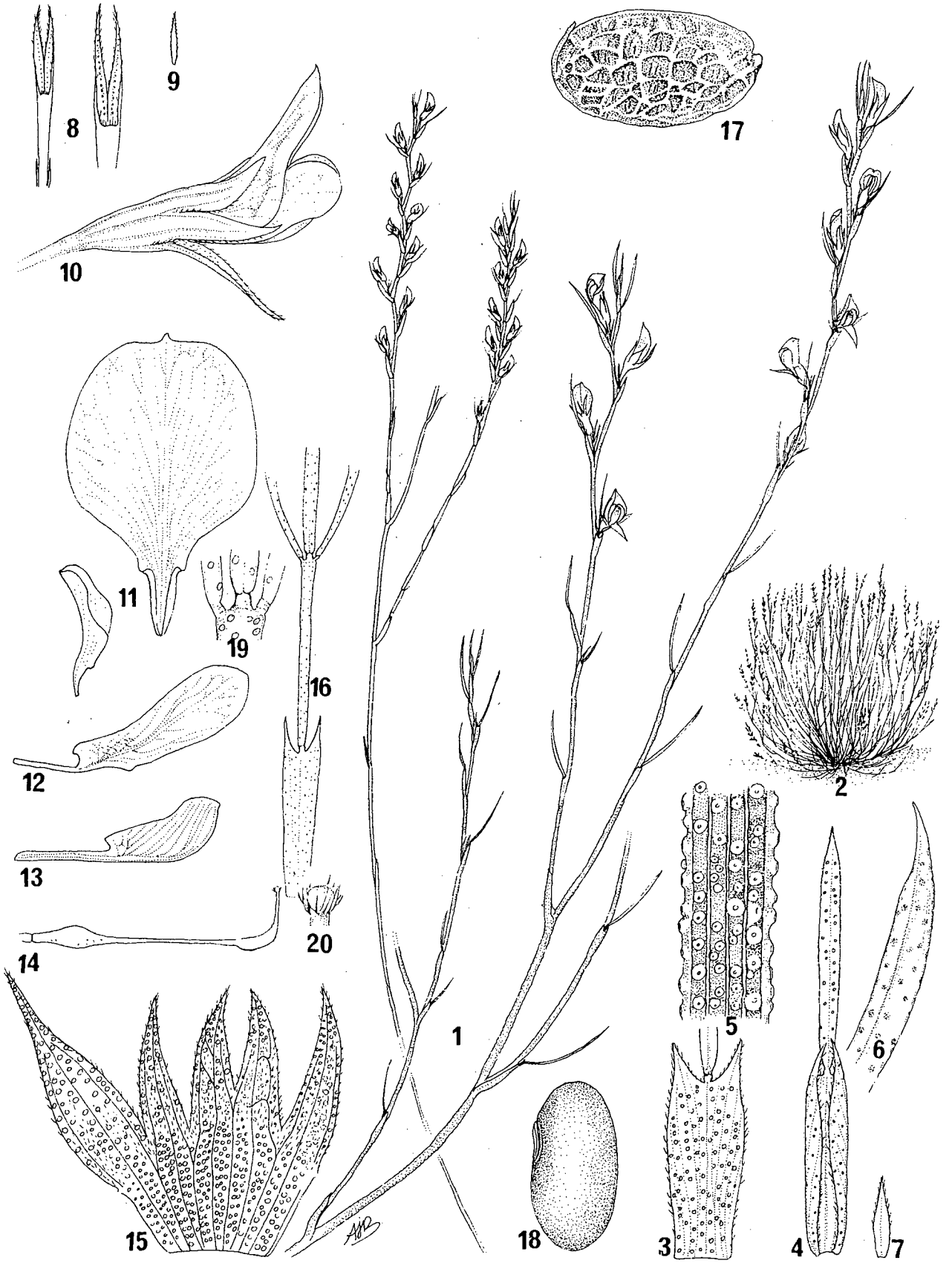
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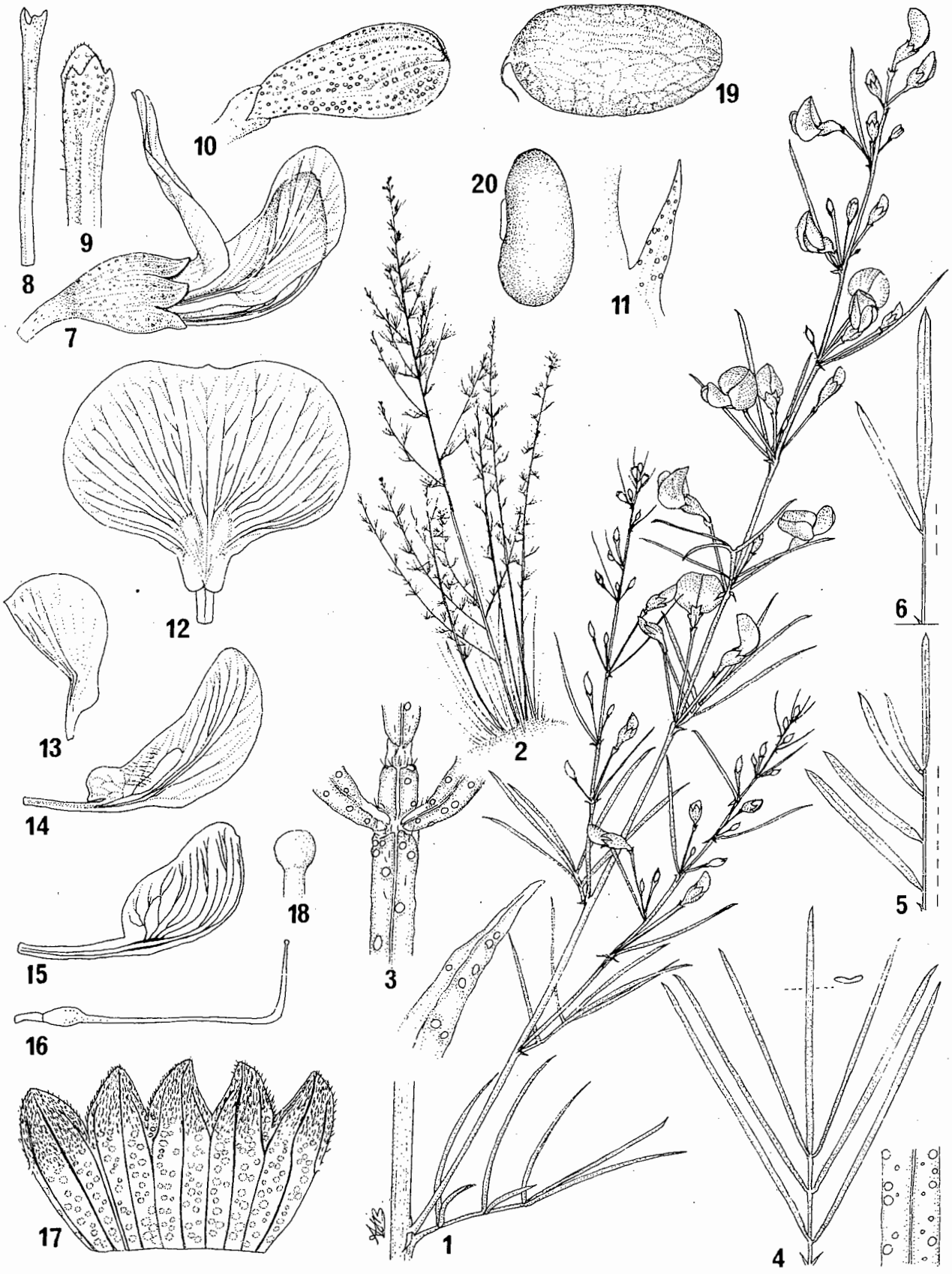
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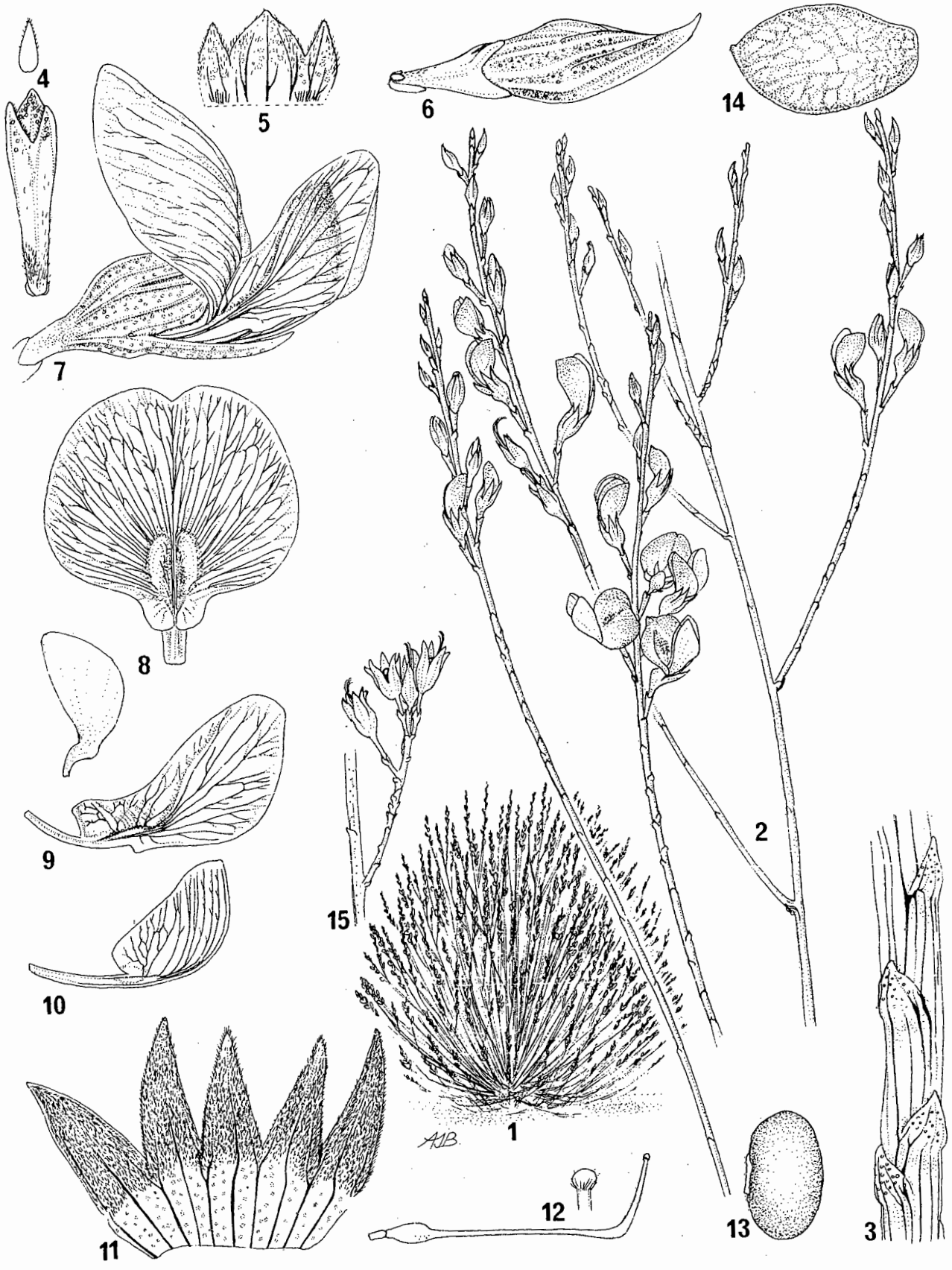
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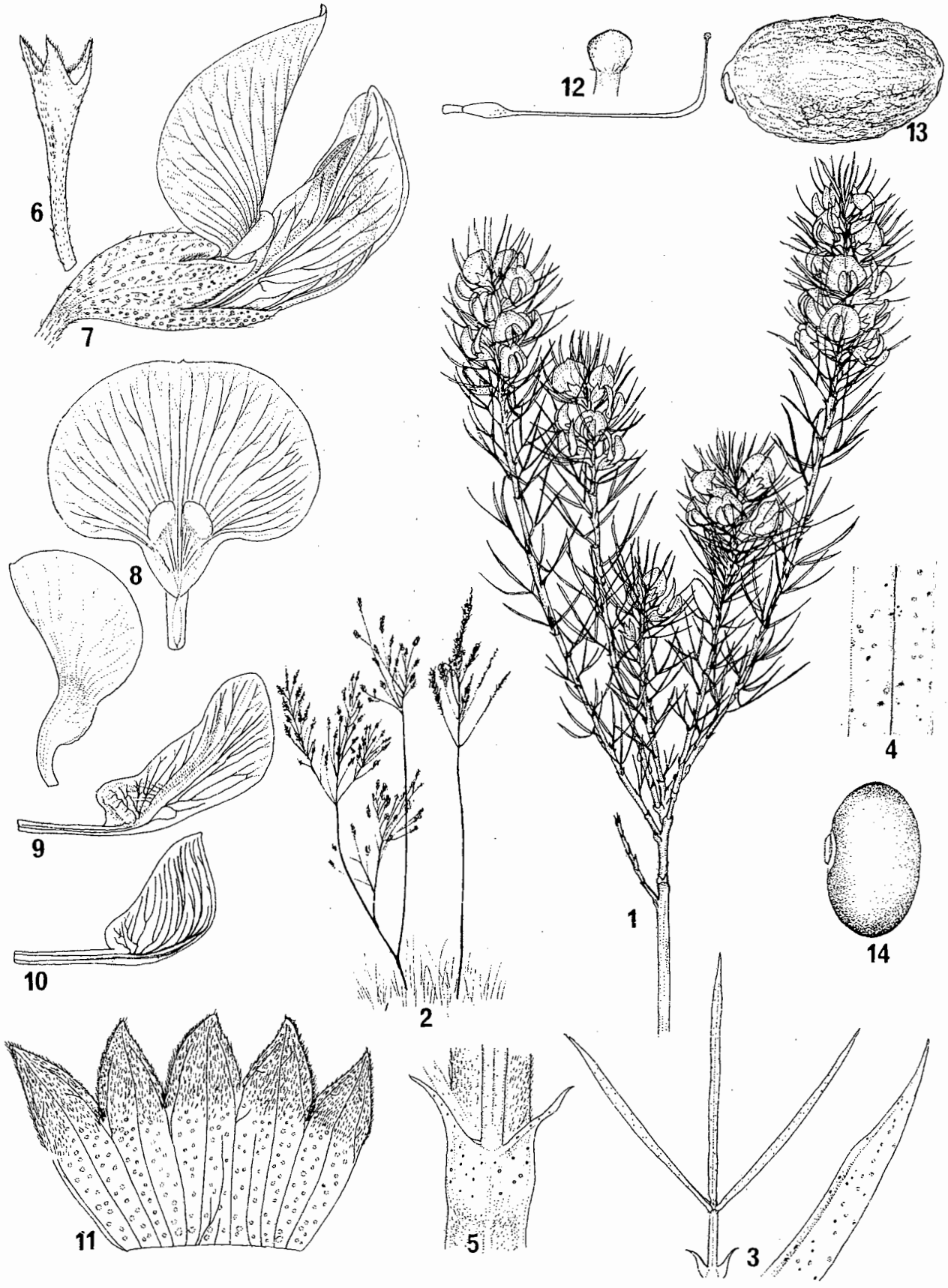
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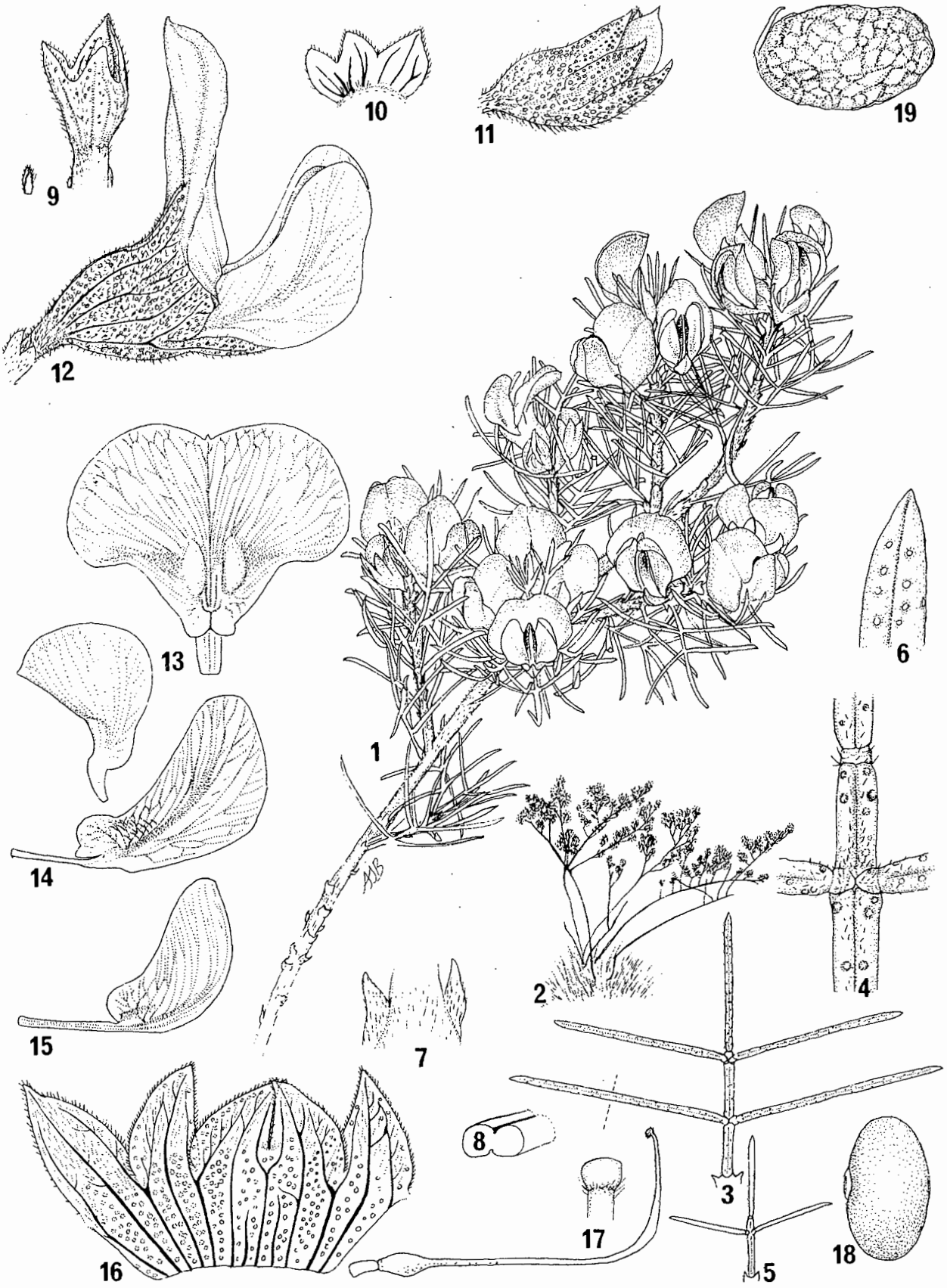
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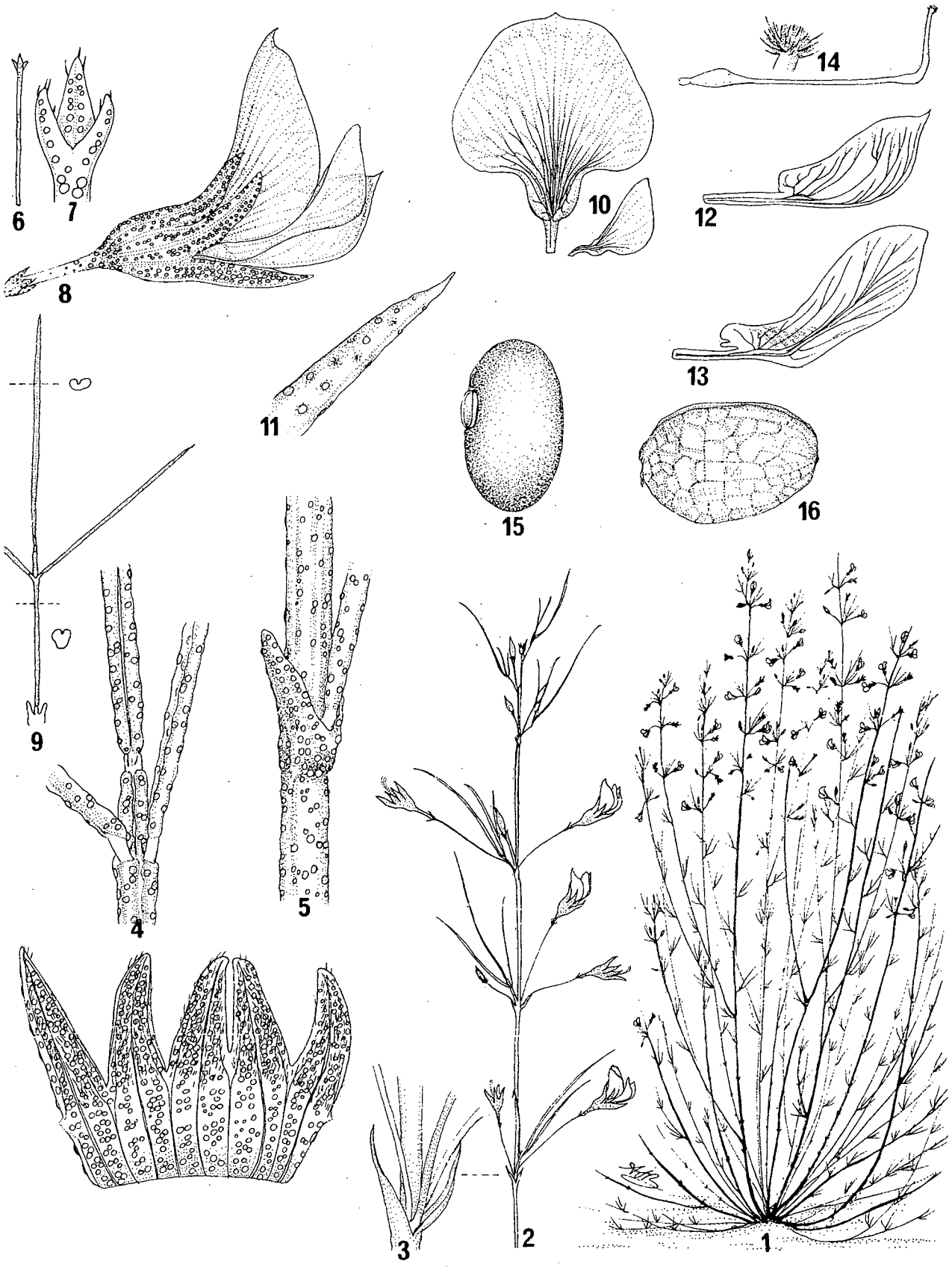
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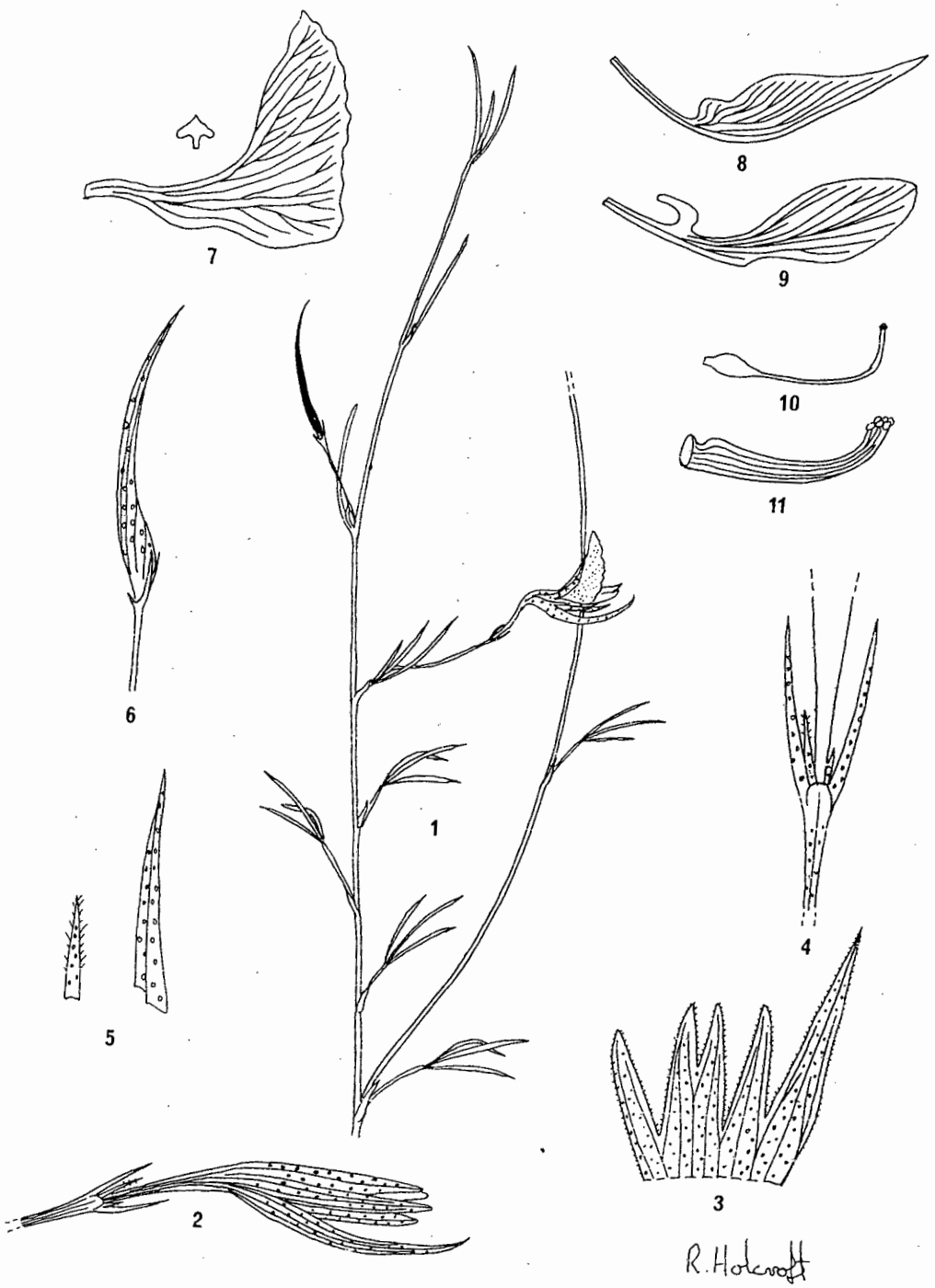
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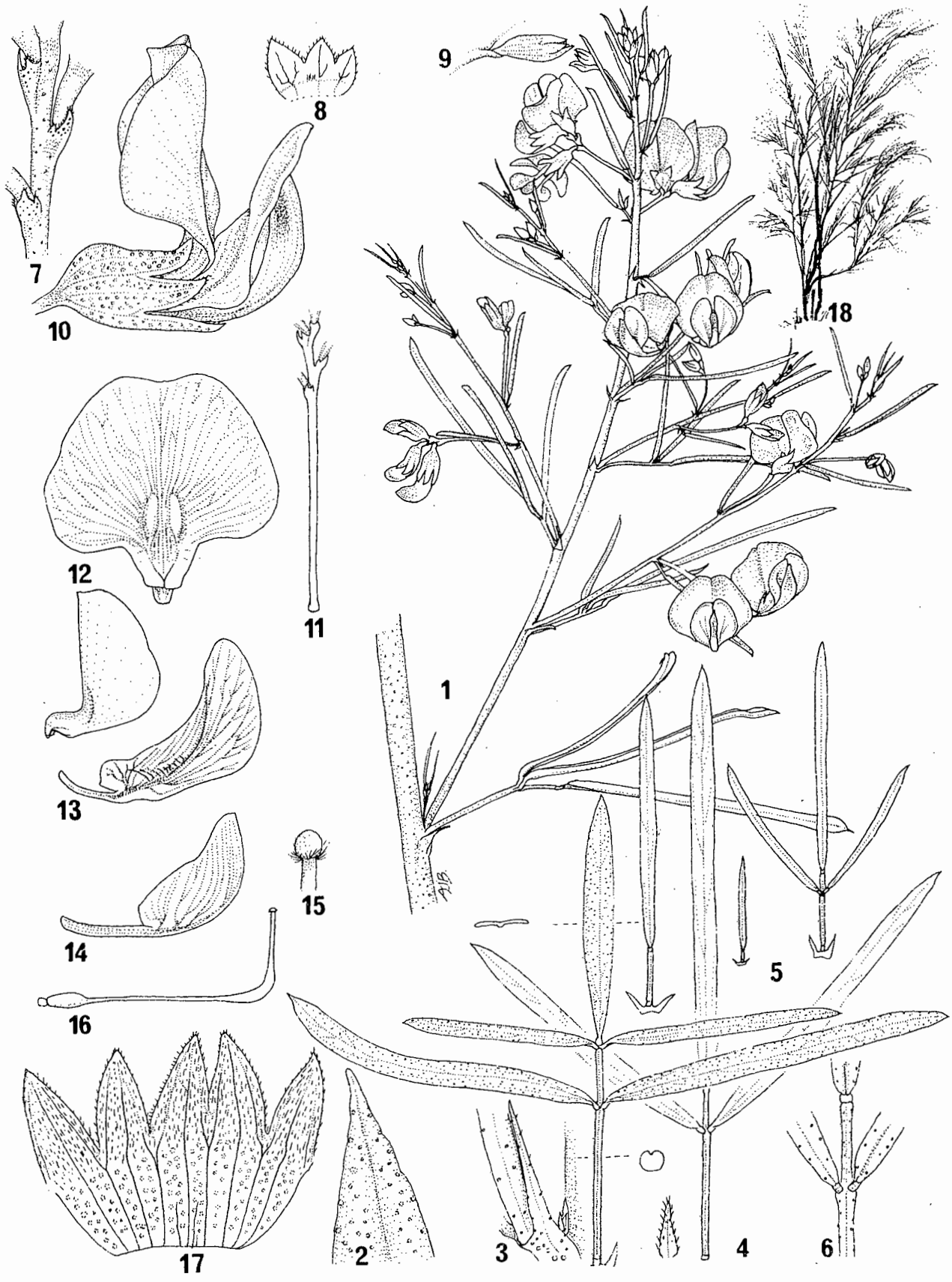
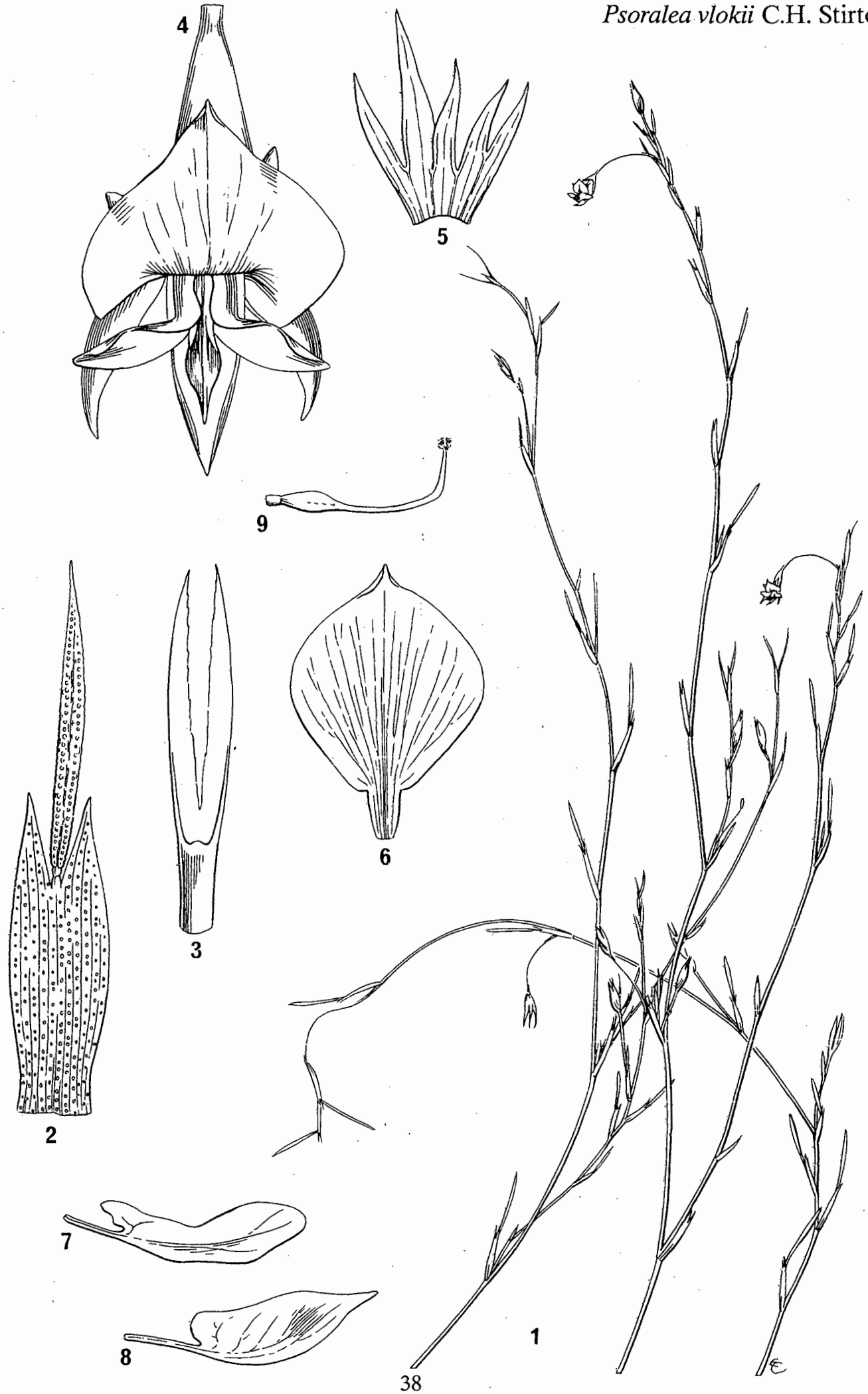
R. Holcroft

Psoralea verrucosa Willd.



Psoralea vlokii C.H. Stirton



APPENDIX 3

Published paper No 1

Stirton, C.H., Field, D.V., Brummitt, R.K., and McNeill, J. 1981. Principles of lectotypification. *Taxon* 30: 251-256.

PRINCIPLES OF LECTOTYPIFICATION

C. H. STIRTON, D. V. FIELD, R. K. BRUMMITT,
AND J. MCNEILL

Made in United States of America
Reprinted from TAXON
Vol. 30, No. 1, February 1981

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Reprinted from TAXON
Vol. 30, No. 1, February 1981

PRINCIPLES OF LECTOTYPIFICATION

The International Code attempts to define the term 'lectotype' in Arts. 7 and 9, while in Art. 8 it rules that the first choice of a lectotype must be followed except in certain circumstances when it may be superseded. The Guide for the Determination of Types, which appears in the Code almost as an afterthought following the Articles and Appendices, also comments on the process of lectotypification. In its paragraphs 4d and 4e the Guide tells us what we *should* do, but does not tell us what is to happen if this advice is ignored. Although the Guide apparently has no legal standing itself, it should certainly be in accord with the requirements of the Articles and Recommendations, and it may be important in interpretation of the Articles where doubt

arises. We are here interested in its effect on interpretation of Art. 8, particularly with reference to acceptance or rejection of lectotypes in the examples of generic names discussed below.

There are several possible lines of argument which may lead botanists to make or reject a lectotypification. Paragraph 4d of the Guide refers to evidence of the original author's intentions, such as "manuscript notes, annotations on herbarium sheets, recognizable figures, and epithets such as *typicus, genuinus, vulgaris, commutatus* etc." These, we are told, should be given preference. Recommendation 7B of the Code, by contrast, recommends that the lectotype should be selected to preserve current usage, which may be quite different from the original author's intentions. Paragraph 4e of the Guide, by contrast again, argues for the so-called "residue method", whereby one is left with a lectotype by successive segregation of other elements into different taxa until only one is left in its original position. Not mentioned at all in the Code are historical arguments such as the pre-Linnaean use of a name, which may, rightly or wrongly, influence the choice of a lectotype. Others again would argue that the major factor to consider is the closeness of fit to the description given by the original author; this approach is obligatory under Art. 9.2 in lectotypification from a mixed collection for names of species and below, and may also be particularly relevant for Linnaean genera—see comments on Linnaeus's method of working by Stearn (1957, pp. 37–38).

Once a lectotypification has been made, Art. 8 rules that this first choice *must* be followed, except in specified circumstances. But it is not always clear what is meant by "the author who first designates a lectotype". Is it necessary to use the word *lectotype*, or at least *type*? Does application of the epithet *typicus* or *genuinus* etc. imply a lectotypification which must be followed? Can annotation of a herbarium sheet constitute designation of a lectotype? And in particular, does the residue method advocated in the Guide, 4e, provide a lectotypification which must be followed?

Among the reasons allowed by Art. 8 for rejection of a lectotypification, the 'misinterpretation of the protologue' can be applied in a variety of ways. Could this include historical arguments, and to what extent do we need to consider the closeness of fit of the included elements to the description? On the latter question very pertinent points are made by Wilbur (1981), to whom we are grateful for sending us a copy of his paper before publication, and these need not be repeated here. One may merely stress the significant, and no doubt beneficial, change introduced into the Code at Seattle through acceptance of proposals 157 and 171 of Tryon (1968). Instead of the former emphasis of previous Codes on the *best fitting* element being chosen as lectotype, the present Code merely allows one to reject a lectotypification if it is directly contrary to the protologue. However, as noted above, this general principle is contradicted by Art. 9.2 which rules that the best fitting element must be chosen as lectotype of a name of a species or lower taxon in the special case of a mixed gathering on a herbarium sheet.

Rejection of a typification "made arbitrarily", introduced into the 1972 Seattle Code, may also be something of a mystery to some. Dictionary definitions of 'arbitrary' all emphasise randomness and lack of any rules, which might apply to many lectotypifications made where there is no particular reason for choosing one element rather than another. Remarkably, however, the main example given of 'arbitrary selection' is that of Britton & Brown (1913), who clearly stated that they were applying fixed rules (those of the 'American Code' published in Bull. Torrey Bot. Club 34: 167–178. 1907) and so their designations of types were the opposite of arbitrary. A proposal on this is given below.

With so much conflicting advice and such unclear rules it is not surprising that attempts to find an answer to many problems of typification of names by reference to the Code are fraught with difficulty. Lectotypification of the name *Stapelia* L. has been discussed by Leach (1975). Linnaeus included only two species, *S. variegata* and *S. hirsuta*, in the protologue in Species Plantarum, 1753. In the following decades many other species were described by various authors in *Stapelia* before Haworth, Synopsis Plantarum Succulentarum, 1812, divided the genus into a number of segregate genera. Haworth referred *S. variegata* L. to his new genus *Orbea*, and *S. hirsuta* L. to *Stapelia*, with no reasons given, each species simply appearing in the middle of a considerable number of others in the same genera. It can be argued, however, that the historical type of *Stapelia* is *S. variegata*; the name goes back to Linnaeus's Hortus Cliffortianus, 1736, where he stated that it commemorated J. van Stapel who was the first to

detect the species, and van Stapel certainly only knew one species, which was *S. variegata* not *S. hirsuta*. According to Heller & Stearn (1958, pp. 105, 144) the first explicit citation of a type for the name *Stapelia* was that by Hitchcock in Hitchcock & Green (1929) who, disregarding Haworth, chose *S. variegata* with the comment that the two species "appear to be equally eligible, though the first (*S. variegata*) was somewhat better known". Later, Phillips (1951) also gave *S. variegata* as the type. However, Leach (1975), forced to make an important decision because he recognises segregate genera, has argued that Haworth's action in transferring *S. variegata* to *Orbea* was implicit lectotypification of *Stapelia* in the sense of *S. hirsuta*, and he has reinstated *Orbea* while confining *Stapelia* to a group including *S. hirsuta*. The card edition of Index Nominum Genericorum gave *S. variegata* as the type, quoting Phillips, not Hitchcock, as the authority for the choice; surprisingly the book edition (Farr, Leussink & Stafleu, 1979) also gives *S. variegata* but quoting Haworth, 1812, and Leach's paper of 1975 as the authority, which seems to be a complete misinterpretation of Leach.

How can we interpret this case in the light of the Code's rulings and recommendations? Is Haworth's implicit lectotypification by the residue method, as recommended in the Guide, paragraph 4e, to be accepted as the first choice of a lectotype? If so, could it then be superseded on the grounds that since Haworth gave no reasons for his choice it was quite arbitrary? Or do we disregard Haworth since he did not mention a type and operated long before the type concept became established, so that we should then follow the explicit choice of Hitchcock in 1929. Or then again should Hitchcock & Green be disregarded because they deliberately avoided calling their choices "types" but regarded them as "standard species" which "may or may not be the type of the original author" (Hitchcock & Green 1929, p. 113): in this case the first explicit choice of a type is by Phillips, as given in the card edition of I.N.G. Is it relevant that the choice of both Hitchcock and Phillips happens to be the 'historical type'? Would it be relevant to examine the original description of the genus by Linnaeus, 1754, and try to ascertain which of the two species fits it most closely? As noted above, the latter is actually a procedure which may be particularly appropriate in typifying Linnaean generic names, but in the actual case of *Stapelia* the original generic description could equally fit either species.

Our second example concerns lectotypification of the name *Psoralea*, also published by Linnaeus in Species Plantarum, 1753, when eight species were included. The name *Psoralea* goes back to 1740 when it was coined by van Royen for a genus in which he included only two species, named by Linnaeus in 1753 as *P. pinnata* and *P. aculeata*. The historical type would thus be one of these two species, and since the former was known to several authors before 1740, who were cited by van Royen, while the other was given only a very brief mention by him, it can be argued that *P. pinnata* would be the natural choice on historical grounds. *P. pinnata* and *P. aculeata* are also the two species which best match Linnaeus's generic description. However, Medikus (Vorles. Churpf. Phys. Oek. Ges. 2: 380–382. 1787), in dividing the Linnaean concept of *Psoralea* into several different genera, placed *P. pinnata* and *P. aculeata* in a new genus *Ruteria* and retained two other species, *P. americana* and *P. glandulosa*, in *Psoralea*. In contrast, Britton & Brown (1913) gave a fifth species out of the original Linnaean eight, *P. bituminosa*, as the type, the reason for this being somewhat obscure since *P. pinnata*, not *P. bituminosa*, was the first species listed by Linnaeus. Green, in Hitchcock & Green (1929), in choosing a 'standard-species', rejected Britton & Brown's typification in favour of *P. pinnata*, which she gave as "the best known of the original species, and the type", also observing that it was one of the original species of van Royen. Phillips (1951) has also given *P. pinnata* as the type of *Psoralea*. Index Nominum Genericorum (1979) makes no reference to the residue method but quotes both Britton & Brown's and Green's choices.

The arguments here are very similar to those in the *Stapelia* case. The residue method recommended in the Guide would restrict choice of a lectotype to either *P. americana*, now regarded as congeneric with *P. corylifolia* L. which is the type of another of Medikus's segregate genera, *Cullen*, or *P. glandulosa*, currently referred to *Orbexilum*, as the type of *Psoralea*. Further research would be needed to determine which of these two species was left alone in *Psoralea* longest. If the residue method is relevant to typification and must be followed, can Medikus's restriction of the genus to two of the original species be disregarded as a misinterpretation of the protologue, on the grounds that in the protologue Linnaeus (Gen. Pl.) actually attributed the name to van Royen who knew neither of these two species? Through such an

argument historical considerations might become significant facts in interpretation of Art. 8. If Medikus's treatment is not relevant to lectotypification one must consider Britton & Brown's choice. Apparently the example in Art. 8 implies that all Britton & Brown's designations of types may be rejected, but, as noted above, their choice in the case of *Psoralea* was not in fact the first species given by Linnaeus in the Species Plantarum. If their choice of *P. bituminosa* is to be rejected, then one moves on to Green, and later Phillips, who chose the historical type, *P. pinnata*.

The above examples both concern generic names, and the problem is likely to be very frequently met with at this level. Close examination of the works of Medikus will probably reveal many more cases like that of *Psoralea* where he has divided up Linnaeus's generic concepts in a way which few modern authors follow but which could be relevant to typification of names of Linnaean genera if the residue method is to be followed. The same principles apply equally at specific level and below, where original syntype specimens may have been successively segregated off from the original concept of a taxon. An example of this is that of the typification of *Panicum glaucum* L., Sp. Pl. 56 (1753). Throughout this century two alternative and widely disparate typifications have had almost equal support among the botanical community. The one applies the epithet to the weedy yellow bristly foxtail which is then called *Setaria glauca* (L.) Beauv. (*S. lutescens* auct. non (Weigel) F. T. Hubbard; *S. pumila* (Poiret) Roemer & Schultes) and the other to the cultivated pearl millet which might then be called *Pennisetum glaucum* (L.) R. Br. (*P. americanum* (L.) Leeke; *P. typhoides* (Burm.f.) Stapf & C. E. Hubbard). Terrell (1976) has recently argued in favour of the first typification, the main justification for this being that in 1759, Linnaeus himself appears to have restricted *P. glaucum* to the yellow bristly foxtail element. Kerguelen (1977), on the other hand, regards the epithet *glaucum* as applying to pearl millet, believing that this element better fits Linnaeus's protologue. It is probably true that were typification being attempted *de novo* the pearl millet element would be a natural choice (although there is some doubt as to whether the Hermann specimen that provides its basis was available to Linnaeus in 1753), but under the terms of Art. 8, the critical matter is who first lectotypified *Panicum glaucum*. Was it Linnaeus in 1759 or one of the succession of later authors who discussed this problem (for references see Terrell 1976 and McNeill & Dore 1976), and if so which one? The present wording of Art. 8 gives little guidance.

The problems are complex and might well justify the setting up of a Special Committee. However, in the hope of getting a more immediate solution we put forward definite proposals below.

From a practical view-point we find explicit citation of a type easier to determine than lectotypification by the residue method. It is often difficult to trace who was the first to segregate one or more of the original species included in a genus, and if it should be a case of tracing, say, the first seven out of eight original species to be removed then one's chances of being correct may be slight. In cases where an author recognizes segregate genera by description only, without saying which species are included in which genera, the problems may be insuperable. Although no comprehensive bibliography of lectotypifications exists there is now a considerable body of literature on this subject, and the facts, once brought to light, are usually indisputable. We thus prefer to place emphasis on explicit lectotypification.

Proposal (148). Add to Art. 8 a Note 1:

"Designation of a lectotype requires explicit citation of the type by use of the words 'lectotype', 'type', 'standard species' or an equivalent term. It is not achieved merely by the exclusion from the taxon of all save one of the original elements." The example of *Stapelia* or *Psoralea* given above may be added if desired.

The inclusion of 'standard species' in the above wording would remove any doubt as to whether the Hitchcock & Green choices are designations of types or not.

Proposal (149). Delete Recommendation 7B and transfer the present wording preceded by "Other things being equal" to the Guide for the Determination of Types.

As noted above, Recommendation 7B may well often be in conflict with paragraphs 4d and

4e of the Guide. It is illogical to give this as a Recommendation while other similar considerations are placed in the Guide.

Proposal (150). In Art. 8 replace the words "made arbitrarily" by "based on a largely mechanical system". Also in the Example delete the last sentence, and insert instead "All these choices of lectotypes by Britton & Brown are thus based on a largely mechanical system and so may be superseded."

As noted above, the present use of "arbitrary" in the Code in relation to Britton & Brown is quite at variance with the meaning of the word. Dictionary definitions of "arbitrary" include "derived from mere opinion or random choice" (Oxford), "not governed by any fixed rules or standard" (Webster), "arising from accident rather than from rule" (Chambers), and "capricious" (all three). According to these definitions many currently accepted lectotypifications would be in danger of being superseded as 'arbitrary' if the author appeared not to have followed any rules or principles in making his choice. The presence in the glossary by McVaugh, Ross & Stafleu (1968) of two other definitions of 'arbitrary' in nomenclatural contexts (for Arts. 20.1 and 23.2 and for Rec. 75A.3), both in senses conflicting with usage of the word in Art. 8, is an additional argument for removing the word from this Article.

The present wording was introduced into the Code through a proposal from the floor at the Seattle Congress (see Stafleu & Voss, 1972, pp. 14 and 25–28). As is evident from the discussion, the main intention was to find a way of enabling the Britton & Brown (1913) types to be superseded, a no doubt laudable objective. It was pointed out that their choice of types was based on a "mechanical system" which was already proscribed in the Guide for the Determination of Types as "unscientific and productive of possible future confusion and further change". It would, therefore, have been much better to have used the words "based on a mechanical system" in the wording of the Article instead of "arbitrarily" which has quite the opposite meaning. Because the American Code which Britton & Brown followed was not entirely a mechanical system, several qualifying conditions being attached to the main directive of choosing the first species given in the protologue, we have preferred in our proposal to suggest "largely mechanical system".

The Example in Art. 8 cites Britton & Brown and gives as an example of their typifications that of "*Delphinium* L. (a genus assigned by its author to Polyandria Trigynia) by *D. consolida* L. (a unicarpellate species)". This seems doubly confusing, for the emphasis seems to be on the contrast between the description of the genus by the original author and the character of the lectotype species, which is quite a separate issue from whether the lectotype was either chosen arbitrarily or based on a mechanical system. It is not even a good example of misinterpretation of the protologue, and it would appear to be best deleted. It is hoped that the suggested re-wording of the Example will make it clear that *all* Britton & Brown choices of lectotypes may be superseded, including those like that in *Psoralea* where their choice was not the first in order in the original publication, and so avoid any possible ambiguity on this point existing under the present Code. Another Example, to cover misinterpretation of the protologue, is provided in the following proposal.

Proposal (151). Add to Art. 8 a second Example:

"The first designation of a lectotype of the name *Vaccinium* Linnaeus, applied to a genus assigned by its author to Octandria Monogynia and described as having a 4-partite corolla, was that of *V. myrtillus* Linnaeus by Hitchcock in A. S. Hitchcock & M. L. Green, Proposals by British Botanists: 150. 1929. Because the species always has a pentamerous perianth and 10 stamens its choice is considered to represent a misinterpretation of the protologue, and is correctly superseded by Vander Kloet's designation of *V. uliginosum* Linnaeus as lectotype in Taxon 30 (in press)."

Proposal (152). In Art. 8, after "misinterpretation of the protologue" insert "or is contrary to Art. 9.2."

Art. 9.2 makes it obligatory to choose the element best fitting the original description in

choosing a lectotype from a mixed gathering. A choice which can be shown to be contrary to this Article should presumably be superseded. As noted above, there is an important difference between choosing an element best fitting the description and rejecting an element chosen through misinterpretation of the protologue. An alternative, which might seem more logical, would be to relegate Art. 9.2 to the Guide for the Determination of Types, replacing the present "must" by "should."

References

Britton, N. L., and A. Brown. 1913. *An Illustrated Flora of the Northern United States, Canada and the British Possessions*. Ed. 2. 3 volumes. New York.

Farr, E. R., J. A. Leussink, and F. A. Stafleu. 1979. *Index Nominum Genericorum (Plantarum)*. 3 vols. Utrecht and The Hague.

Heller, J. L., and W. T. Stearn. 1958. An appendix to the *Species Plantarum* of Carl Linnaeus. Ray Society, London. (Reprinted in facsimile edition of *Species Plantarum*, vol. 2, 1959).

Hitchcock, A. S., and M. L. Green. 1929. Standard species of Linnean genera of Phanerogamae (1753–54). International Botanical Congress, Cambridge (England), 1930: Nomenclature: Proposals by British Botanists: 111–199. H.M.S.O., London.

Kerguélen, M. 1977. Notes agrostologiques. II. *Bull. Soc. Bot. Fr.* 124: 337–349.

Leach, L. C. 1975. The lectotype species of *Stapelia* L. and the re-instatement of *Orbea* Haw. (Asclepiadaceae). *Kirkia* 10: 287–291.

McNeill, J., and W. G. Dore. 1976. Taxonomic and nomenclatural notes on Ontario Grasses. *Naturaliste Can.* 103: 553–567.

McVaugh, R., R. Ross, and F. A. Stafleu. 1968. An annotated glossary of botanical nomenclature. *Regnum Vegetabile* 56. Utrecht.

Phillips, E. P. 1951. *The Genera of South African Flowering Plants*. Ed. 2. Pretoria.

Stafleu, F. A., and E. G. Voss. 1972. Report on botanical nomenclature, Seattle 1969. *Regnum Vegetabile* 81. Utrecht.

Stearn, W. T. 1957. An introduction to the *Species Plantarum* and cognate botanical works of Carl Linnaeus. In facsimile edition of Linnaeus, C., *Species Plantarum* 1753. Ray Society, London.

Terrell, E. E. 1976. The correct names for pearl millet and yellow foxtail. *Taxon* 25: 297–304.

Tryon, R. 1968. Proposals by Rolla Tryon. *Taxon* 17: 588–590.

Wilbur, R. L. 1981. The unnecessary conservation of generic lectotypes. *Taxon* 30: 39–42.

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APPENDIX 4

Published paper no 2

Stirton, C.H. 1984. Name changes in *Psoralea* (Fabaceae). *Jl. S. Afr. Bot.* 50,4: 461-462.

Jl S. Afr. Bot. 50 (4): 461–462 (1984)

NAME CHANGES IN *PSORALEA* (FABACEAE)

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ABSTRACT

1. The new combination *Psoralea monophylla* (L.) C. H. Stirton is made, based on *Glycine monophyllum* L. 2. The new name *Psoralea plauta* C. H. Stirton is designated for *Hallia flaccida* Thunb. (1799), non *P. flaccida* Näbelék (1923). 3. The new name *P. cataracta* C. H. Stirton is designated for *H. filiformis* Harv. (1836), non *P. filiformis* Poir. (1804).

UITTREKSEL

NAAMSVERANDERING IN *PSORALEA* L. (FABACEAE)

1. 'n Nuwe kombinasie *Psoralea monophylla* (L.) C. H. Stirton word gemaak, gebasseer op *Glycine monophyllum* L. 2. Die nuwe naam *Psoralea plauta* C. H. Stirton word gegee aan *Hallia flaccida* Thunb. (1799), non *P. flaccida* Näbelék (1923). 3. Die nuwe naam *P. cataracta* C. H. Stirton word aan *H. filiformis Harv. (1836),* non *P. filiformis* Poir. (1804) gegee.

Key words: *Psoralea*, Fabaceae.

1. **Psoralea monophylla** (L.) C.H.Stirton, comb. nov.

Glycine monophyllum L., Syst. nat. ed. 12, 2: 484 (1767); Mant. pl. 101 (1767); Mant. pl. Alt. Addim. 516 (1771); non Burm. 1768; auct. non L.: Jacq., Pl. Hort. Schoenbr. 2: 57, t. 257 (1797). Lectotype: "C.B.S." (LINN, specimen 901. 20, !).

Hedysarum cordatum Thunb. in Nov. Act. Reg. Soc. Sci. Upps. 6: 41 (1799); non Jacq. (1800). Lectotype: "Crescit in campis graminosis ultra Swellendam, C.B.S." (UPS, specimen *17161*). Nomenclaturally superfluous name. *Hallia cordatum* (Thunb.., Schrad. Journ. 1: 321 (1799); Gen. nov. Pl. 11: 158 (1800); Prodr. 131 (1800); W. T. Aiton, Hortus Kew. 4: 338 (1812); Thunb., Fl. Cap. 593 (1823); DC., Prodr. 2: 123 (1825); Eckl. & Zeyh., Enum. 172 (1836); E. Mey., Comm. 82 (1836). *Psoralea cordata* (L.)

*B. A. Krukoff Botanist

Accepted for publication 25th May, 1984.

Salter in Jl S. Afr. Bot. 5: 46 (1939); Salter in Adamson & Salter, Fl. Cape Penins. 490 (1950).

Salter transferred this species from *Hallia* to *Psoralea* but the basionym *Hedysarum cordatum* L. does not exist.

Hedysarum saggitatum Poir., Encyl. 6: 403 (1804). Type: not seen.

Hallia saggitata (Poir.) Desv., Ann. Sci. Sér. 9: 408 (1826). *Desmodium saggitatum* (Poir.) DC., Prodr. 2: 326 (1825).

2. **Psoralea plauta** C.H.Stirton, nom. nov.

Hallia flaccida Thunb. in Schrad. Journ. 319 (1799); Prodr. 131 (1800); W. T. Aiton, Hortus Kew. 4: 338 (1812); Thunb. Fl. Cap. 593 (1823); DC., Prod. 2: 123 (1825); Eckl. & Zeyh., Enum. 172 (1836). Lectotype: South Africa, "e Cap. Bon. Spei." *Thunberg s.n.* (UPS, specimen *17162*), non Năbelék (1923).

3. **Psoralea cataracta** C.H.Stirton, nom. nov.

Hallia filiformis Harv. in Harv. & Sond. Fl. Cap. 2: 232 (1836). Type: South Africa, Tulbagh Waterfall, *Pappe s.n.* (TCD, holotype!), non Poir. (1804).

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APPENDIX 5

Published paper No 3

Stirton, C.H. 1985a. Notes on the genus *Otholobium* (Psoraleeae, Fabaceae). *S. Afr. J. Bot.* 52: 1-6.

Notes on the genus *Otholobium* (Psoraleeae, Fabaceae)

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Thirty-one new combinations are made in *Otholobium*, a genus related to *Psoralea, Bituminaria* and *Cullen* in the tribe Psoraleeae. One new species is described: *Otholobium swartbergense* C.H. Stirton. It is a small lax, much branched shrublet with 6 – 15-flowered (purple) hemispherical inflorescences, endemic to the Groot Swartberg Mountains.
S. Afr. J. Bot. 1986, 52: 1 – 6

Een-en-dertig nuwe kombinasies word in *Otholobium*, 'n genus verwant aan *Psoralea, Bituminaria* en *Cullen* in die tribus Psoraleeae, gemaak. Een nuwe spesie, *Otholobium swartbergense* C.H. Stirton word beskryf. Dit is 'n klein slap, veelvertakte struikie met 6 – 15 pers blomme per hemisferiese bloeiwyse, endemies aan die Groot Swartberge.
S.-Afr. Tydskr. Plantk. 1986, 52: 1 – 6

Keywords: Fabaceae, *Otholobium, Psoralea*, taxonomy

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Accepted 28 August 1985

Introduction

The following new combinations arise from an overall survey of generic classification of the tribe Psoraleeae, Papilionoideae (Stirton 1981a, 1981b). In these studies the African representatives of *Psoralea sensu lato* were re-allocated to four genera: *Psoralea* L., *Hallia* Thunb., *Otholobium* C.H. Stirton and *Cullen* Medik. Monographs of these genera will be published elsewhere, and a full list of types and synonyms will be provided then.

The genus *Otholobium* is restricted mainly to south-eastern and eastern Africa, but also extends into the mediterranean-climate areas of South Africa. Unlike *Psoralea* which tends to occur in seepage areas or on wetter slopes, *Otholobium* is more likely to be found in drier habitats.

Otholobium is characterized by a combination of entire recurved-mucronate obovate to oblanceolate leaflets and bracteate triplets of flowers with each triplet subtended by a single variously shaped bract.

Otholobium *C.H. Stirton* in Adv. Leg. Systematics 1,2: 341 (1981).

Shrubs, suffrutices or rarely decumbent herbs. *Leaves* 3-foliolate, stipulate, petiolate, entire nigro-punctate or pellucid-dotted, oblanceolate to obovate, base cuneate, apex acute to obtuse, recurved-mucronate; stipules striate, ovate-acute or subulate-acuminate, pubescent, free or adnate to the base of the petiole. *Flowers* white, yellow or pale blue, sessile or subsessile, aggregated in 1 or 5 – 18 triplets, or rarely doublets, axillary or terminal fascicles, imperfect racemes or lax pseudo-spikes, each flower bracteate, triplets subtended by a single ovate bract, cupulum of *Psoralea* and *Hallia* absent. *Calyx* campanulate, unequally 5-lobed, the lowest lobe much longer and broader than the rest, upper lobes variously connate, very rarely stubby-haired on the inside of the teeth. *Standard* ovate to oblong, claw and auricles weakly developed, appendages absent. *Wings* much exceeding keel, sculpturing lamellate, tips billowy and overlapping. *Keel* long-clawed, deep purple on the inner face at the tip of the obtuse blades. *Anthers* uniform, alternately basifixed and medifixed; vexillary stamen free. *Ovary* sessile, 1-ovulate, glabrous and glandular, or hairy; style swollen; stigma capitate, penicillate or glabrous. *Fruit* swollen, indehiscent, pubescent, slightly beaked, protruding from calyx at maturity. *Seeds* longer than broad, black.

New Combinations

Unless otherwise stated all the type material cited below was examined by the author. Although some of the types have not yet been found, the new combinations have been made

as the protologues usually are informative enough to enable one to understand clearly which species was being described.

There is a real problem in lectotypifying species described in Ernst Meyer's 'Commentario' and Ecklon & Zeyher's 'Enumeratio'. They saw many duplicates of the same collections. Unfortunately a large number of the Meyer names in the legumes are pre-empted by Ecklon & Zeyher by a few months. See Meisner (1843) for a terse analysis of this unfortunate occurrence whereby Ecklon & Zeyher's names take priority. There is little doubt that Ernst Meyer's treatment is superior. He annotated most of the sheets he saw and so it is never difficult to understand his species concept. Ecklon and Zeyher, on the other hand, rarely annotated the sheets that they or their purchasers sent or sold abroad, with or without labels, printed or handwritten. Their collections appear to be distributed among many different herbaria. Much of their material was distributed with printed labels which are clearly from a number of different printings, the material presumably not necessarily from the same original collections. They also made mixed gatherings and so it is often difficult to interpret what they meant, especially as their descriptions are mostly inadequate. However, Nordenstam (1980) made a clear case that herbarium material in S should be the first choice for the lectotypification of Ecklon & Zeyher names. I concur with this and have lectotypified accordingly except in some instances when other herbaria have sheets with clear labels in the authors' handwritings, apparently representing the top sheets.

In a number of cases I have designated neotypes as it has been impossible so far to decide whether any material which the authors may have had at their disposal, exists. In all such instances there has been no problem in determining the species intended. For information about the guidelines used to select lectotypes in this paper also see Stirton *et al.* (1981c).

1. Otholobium acuminatum *(Lam.) C.H. Stirton*, comb. nov.

Psoralea acuminata Lam., Encycl. 3: 173 (1789); Poiret, Tabl. Encycl., 3: 614, t.2 (1794). Eckl. & Zeyh., Enum. 229 (1836). Neotype: Wit Els Bosch flats, 750', October 1920, *Fourcade 937* (BOL). I have been unable to trace the specimen/s on which Lamarck based this species. The protologue is most descriptive so it has been easy to establish a neotype. In the past this species has been misinterpreted by most authors who confused it with *P. bracteolata* Eckl. & Zeyh. under the names *P. bracteata* L. or *P. fructicans* (L.) Druce.

P. densa E. Mey., Comm. 86 (1836). Lectotype: 'Kaymansgat, IV C o, Alt. 500 ped., (George)', *Drège s.n.* (K, lectotype; L, iso). The right-hand specimen of the Kew sheet is chosen as the lectotype.

2. Otholobium argenteum *(Thunb.) C.H. Stirton*, comb. nov.

Psoralea argentea Thunb., Prodr. 136 (1800); Fl. Cap. 608 (1823). DC., Prodr. 2: 218 (1825); E. Mey., Comm. 87 (1836); Harv. in Harv. & Sond., Fl. Cap. 2: 153 (1862); Forbes in Bothalia 3: 129 (1930). Holotype: 'e Cap. Bon. Spei', *Thunberg s.n.* (UPS — Thunb. *17559*, seen on microfiche).

P. albicans Eckl. & Zeyh., Enum. 231 (1836); Walpers, Repert. 1: 657 (1842). Lectotype: 'Inter frutices (Altit. II) laterum montium prope Olifantsrivier (Clanwilliam)', *Zeyher s.n.* (S, lectotype; TCD, S. SAM, iso). The isolectotype from S comprises a mixed gathering: the single left-hand twig is *O. arborescens* C.H. Stirton mss.

P. striata Thunb. var. *gracilis* Harv. in Harv. & Sond., Fl. Cap. 2: 153 (1862).

3. Otholobium bolusii *(Forbes) C.H. Stirton*, comb. nov.

Psoralea bolusii Forbes in Bothalia 3: 123 (1930). Holotype: in mountains near Piquetberg, *Bolus s.n.* (*NH 16913*, holotype; PRE, isotype).

4. Otholobium bowieanum *(Harv.) C.H. Stirton*, comb. nov.

Psoralea bowieana Harv., Fl. Cap. 2: 154 (1862); Forbes in Bothalia 3: 127 (1930). Holotype: 'Cape', *Bowie s.n.* (K, holotype; BM, MO, isotypes). The Kew sheet merely has 'Cape' as locality whereas the BM sheet, which I believe is an isotype, has the following pencil entry: 'on the Buffeljagt River at Goestervalley'. Unfortunately not enough is known about Bowie's collecting localities or the quantity and distribution of his specimens to enable one to decide which is the top sheet. It seems probable that it is the BM material as their sheets are the better annotated.

5. Otholobium bracteolatum *(Eckl. & Zeyh.) C.H. Stirton*, comb. nov.

Psoralea bracteolata Eckl. & Zeyh., Enum. 229 (1836). *Psoralea bracteata* L. var. *brevibracteata* E. Mey. in Linnaea 7: 165 (1832). *P. bracteata* L. var. *bracteolata* (Eckl. & Zeyh.) Harv. in Harv. & Sond., Fl. Cap. 2: 154 (1862). Holotype: 'Fläche bei Doornhoogte, Stellenbosch', *Drège s.n.* (P). Ecklon & Zeyher coined a new name for this species. They did not take up Ernst Meyer's variety *brevibracteatum*.

Psoralea bracteata sensu Jacq., hort. Schoenbr. 2: 54, t.224 (1797) belongs here.

Psoralea algoensis Eckl. & Zeyh., Enum. 229 (1836). Lectotype: 'in dunis arenosis ad litus sinus Algoabay prope fluminis ostium Zwartkopsrivier (Uitenhage)', *Ecklon s.n.* (S, lectotype; BOL, K, STE, TCD, isotypes).

6. Otholobium candicans *(Eckl. & Zeyh.) C.H. Stirton*, comb. nov.

Psoralea candicans Eckl. & Zeyh., Enum. 228 (1836); Walpers, Repert. 1: 657 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 150 (1862); Forbes in Bothalia 3: 122 (1930). Lectotype: 'in lapidosis (Altit. II) in Karoo prope flumen Gauritzrivier (Swellendam)', *Zeyer s.n.* (S, lectotype; K, L. S, SAM, isotypes). I have discovered only four sheets which bear the collector's distribution label. None of the sheets bear labels in the collector's hand. All the sheets have more than one twig present except for the S sheet which I have designated lectotype.

P. hirta Thunb., Fl. Cap 609 (1823) pro parte non L. (1753). Lectotype: 'e Cap. Bon. Spei', *Thunberg s.n.* (UPS — Thunb. left-hand specimen *17573*).

7. Otholobium carneum *(E. Mey.) C.H. Stirton*, comb. nov.

Psoralea carnea E. Mey., Comm. 85 (1836); Harv. in Harv. & Sond., Fl. Cap. 2: 149 (1862); Forbes in Bothalia 3: 131 pro parte (1930). Lectotype: The exact locality is uncertain, said to have come from the area between Piquetberg and False Bay but as the species is restricted to the Kouga Mountains Meyer was correct in doubting its provenance. Collector: *Drège s.n.* (MO, lectotype; K. fragment, isotype). Forbes (1930), in her monograph of *Psoralea*, confused this species with a group of five species centred on *P. carnea*. I recognize these as *Otholobium prodiens* C.H. Stirton mss.; *O. heterosepalum* (Fourcade) C.H. Stirton; *O. polyphyllum* (Eckl. & Zeyh.) C.H. Stirton; *O. stachyerum* (Eckl. & Zeyh.) C.H. Stirton and *O. acuminatum* (Lam.) C.H. Stirton. I will deal with their identification and relationships in a later monograph.

8. Otholobium decumbens *(Ait.) C.H. Stirton*, comb. nov.

Psoralea decumbens Ait., Hort. Kew. 3: 80 (1789); Lodd. Bot. Cab. t.282 (1818); DC., Prodr. 2: 217 (1825); E. Mey., Comm. 86 (1836); Eckl. & Zeyh., Enum. 228 (1836); Walpers in Linnaea 13: 514 (1839); Forbes in Bothalia 3: 136 (1930); Adamson & Salter, Fl. Cape Penins. 488 (1950); Kidd, Wildfl. Cape Penins. t.70,3 (1950). Holotype: without precise locality, *Masson s.n.* (BM).

P. ononoides Lam., Method. 5: 688 (1804) non Burm. f. (1768). Holotype: 'Cap de Bonne-Esperance', *Sonnerat s.n.* (P-JA).

Ononis decumbens Sieb. nom. nud. This name appears frequently on early herbarium sheets.

P. hirta Thunb., Fl. Cap. 609 (1823) pro parte non L. (1753). The LHS specimen of the type sheet (*17573*) in UPS — Thunb. is *O. candicans* (Eckl. & Zeyh.) C.H. Stirton whereas the RHS specimen is *O. decumbens*.

9. Otholobium foliosum *(Oliv.) C.H. Stirton*, comb. nov.

Psoralea foliosa Oliv. in Journ. Linn. Soc., Bot. 21: 399 (1885). Burtt Davy. Fl. Pl. & Ferns Transv. 374 (1932); White, For. Fl. North. Rhod.:

161 (1962). Holotype: Laikipia [Lykipia], Kenya, *Thomson s.n.* (K).

10. Otholobium fruticans *(L.) C.H. Stirton,* comb. nov.

Trifolium africanum fruticans flore purpurasente. Comm., Horti med. amstelod. 2: 211, t.106 (1701) and Atlas 5, t.33; Hill, Eden. 103, t. 9.6 (1757). Wijnands (1983) reports that in 1697 Commelin received from the Cape some seeds of this species, sent as *Lagopus frutescens* but presumably meant to be *Sutherlandia frutescens.*

Trifolium africanum lagopodiodes, frutescens; foliis uva ursinia, punctatis. Rai., Suppl. 464 (1704).

Cytisi facie frutex, Capitis bonae-spei, foliis perforatis. Petiv. Gaz. 23 (1702).

Trifolium spicis subvillosis; lacinia calicum infima maxima, foliis fere sessilibus. L., Hort. Cliff. 373 (1737); Roy. Lugd. Batav. 378 (1740); Fabricius, Enum. Ed. 2: 305 (1763).

Trifolium fruticans L., Sp. Pl. 770 (1753); Burm. f., Prodr. Fl. Cap. 22 (1768); L., Mant. Pl. altera 452 (1771). *Psoralea bracteata* Berg., Descr. pl. Cat. 224 (1767), nom. illeg. The name is illegitimate since *Trifolium fruticans* L. was given as a synonym and is automatically rejected as being superfluous. Thunb. 136 (1800); Thunb., Fl. Cap. 608 (1823); L., Mant. 264 (1767); L., Mant. Pl. altera 264 (1771); Curtis, Bot. Mag. 13: 446 (1799); Poir. in Lam. Encycl. 5: 687 (1804); Eckl. & Zeyh., Enum. 229 (1836); E. Mey., Comm. 86 (1836); Richter, Codex 739 (1840); Walpers, Repert. 1: 657 (1842); DC., Prodr. 2: 218 (1825); Harv. in Harv. & Sond., Fl. Cap. 2: 154 (1862); Forbes, Bothalia 3: 126 (1930). Lectotype: provenance and collector unknown (BM, Hort. Cliff. *373.5*).

Ononis trifoliolata L., Syst. Nat. 12,2: 479 (1767).

P. cuneifolia Du Mont de Courset, Le Bot. cult. 6: 101, ed. 2 (1812). Type: Herbarium and types unknown (fide Stafleu & Cowan, Taxon. Lit. 1: 696, 1976).

P. aculeata Thunb., Fl. Cap. 607 (1823) non L. (1753).

P. bracteata L. var. *curtisiana* E. Mey. Comm. 86 (1836). Type: I have not been able to trace a specimen of the variety.

P. fruticans (L.) Druce, Rep. Bot. Exch. Bri. Isles 1913: 422 (1914); Kidd, Wildlflow. Cape Penins. t.70.7 (1950); Adamson & Salter, Fl. Cape Penins. 487 (1950).

Lotodes fruticans (L.) O.K., Gen. Pl. 3,2: 65 (1891).

11. Otholobium hamatum *(Harv.) C.H. Stirton,* comb. nov.

P. hamata Harv. in Harv. & Sond., Fl. Cap. 2. 152 (1862) non sensu Forbes (1930). Holotype: 'Roodeberg', *Drège s.n.* (K). The specimen in K bears Harvey's determinavit slip. I have not come across any other sheets with Harvey's writing so I presume that this is the holotype. Some authors, eg. E. Mey., Comm. 87 (1836), have confused this species with *Psoralea racemosa* Thunb.

12. Otholobium heterosepalum *(Fourcade) C.H. Stirton,* comb. nov.

Psoralea heterosepalum Fourcade in Trans. Roy. S. Afr. 21: 95 (1932). Lectotype: The Heights, *Fourcade 4225* (BOL). The sheet in Fourcade's herbarium is a mixed gathering. The right-hand specimen is a good match of the protologue and is here designated the lectotype. This specimen matches the two duplicates in BOL. The left-hand specimen of *Fourcade 4225* in Fourcade's herbarium is *Otholobium prodiens* C.H. Stirton mss.

13. Otholobium hirtum *(L.) C.H. Stirton,* comb. nov.

Psoralea hirta L., Pl. Rar. Afr. 15 (1760) non Willd. (1802). Kidd, Wildflow. Cape Penins. t.70 (1950); Adamson & Salter, Fl. Cape Penins. 487 (1950). Neotype: Leeurivier, between Wolseley and Tulbagh, 4-12-1981, *Stirton 10126* (K). It has been very difficult to establish what might be the type of this species. The material named *hirta* in L.f.'s hand in LINN (*928.15* and *928.17*) is all *Otholobium decumbens* (Ait.) C.H. Stirton and it appears that he misinterpreted his father's concept of *hirta*. LINN *928.15* is a mixed sheet with four pieces. LINN *928.17* was originally named *Psoralea aculeata* and is marked 'Tulbagh List c.1769 no. 60'. Both these collections postdate the original publication of *P. hirta* so are not available for lectotypification. There are no sheets of *hirta* in S.

P. stachydis L.f., Suppl. 338 (1781); Gmelin, Syst. nat. ed. 13, 2: 1138 (1791); Poir. in Lam., Encycl. 5: 689 (1804); DC., Prodr. 2:218 (1825); Walp, in Linnaea 13: 515 (1839); Harv. in Harv. & Sond., Fl. Cap. 2: 152 (1862); Forbes in Bothalia 3: 314 (1930). Holotype: 'Habitat in Cap. Bonae Spei', *Thunberg s.n.* (LINN *928.10*).

P. stachyos Thunb., Prodr. 136 (1800) nom illegit.; E. Mey. in Linnaea 7: 165 (1832); Eckl. & Zeyh., Enum. 231 (1836); Harv. in Harv. & Sond., Fl. Cap. 2: 608 (1862).

P. hirta L. var. *jacquiniana* DC., Prodr. 2: 217 (1825); Jacq., Hort. Schoenbr. 2: t.228 (1797). Holotype: Without locality, *Sonnerat s.n.* (P-JA).

14. Otholobium macradenium *(Harv.) C.H. Stirton,* comb. nov.

Psoralea macradenia Harv. in Harv. & Sond., Fl. Cap. 2: 148 (1862); Forbes in Bothalia 3: 132 (1930). Lecotype: Wanhoop, Swartberg Mountains, *Alexander Prior s.n.* (K, lectotype; BOL, TCD, isotypes). Syntype: Mountains of Graaff Reinet, *Barber s.n.* (K, TCD).

15. Otholobium mundianum *(Eckl. & Zeyh.) C.H. Stirton,* comb. nov.

Psoralea mundiana Eckl. & Zeyh., Enum. 228 (1836); Walp. in Linnaea 1: 656 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 148 (1862); Forbes in Bothalia 3: 122 (1930). Lecotype: 'Prope Gorreehoogde, Swellendam', *Mund 84* (K, lectotype; S, *SAM 49206*, isotype).

P. spathulata E. Mey., Comm. 85 (1836); Walp., Repert. 1: 656 (1842). Lectotype: 'In montosis rupestribus Dutoitskloof', *Drège s.n.* (K, lectotype; GBH, isotype).

P. decumbens Willd. (1802) non Ait. (1789).

16. Otholobium obliquum *(E. Mey.) C.H. Stirton,* comb. nov.

Psoralea obliqua E. Mey. in Linnaea 7: 164 (1832); Comm. 84 (1836); Walp., Repert. 1: 656 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 148 (1862); Forbes in Bothalia 3: 131 (1930). Lectotype: 'In montosis rupestribus humidioribus ad montem Paarlberg', *Drège s.n.* (PRE, lecto; BM, GBH, L, TCD, iso). Syntype: 'Prope Stellenbosch' *Drège s.n.* (K, MO); 'Dutoitskloof', *Drège s.n.* (PRE). In the protologue Meyer cited 'Hottentots Holland' as the locality. I have not come across any specimens that bear such a legend. Neither is it mentioned in Meyer's later more important work, his 'Commentario'. In this work he lists the above localities. I have concluded therefore that his original citation of Hottentots Holland referred to a general area or was an imprecise locality. I have lectotypified the 'Paarlberg' specimen in PRE as it best matches the protologue and is duplicated in a number of herbaria.

17. Otholobium parviflorum *(E. Mey.) C.H. Stirton,* comb. nov.

Psoralea parviflora E. Mey., Comm. 86 (1836). Lectotype: 'Dutoitskloof, III A e', *Drège s.n.* (K, lectotype; GBH, L, PRE, isotype).

18. Otholobium polyphyllum *(Eckl. & Zeyh.) C.H. Stirton,* comb. nov.

Psoralea polyphylla Eckl. & Zeyh., Enum. 227 (1836); Walp. in Linnaea 13: 513 (1839); Walp., Repert. 1: 656 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 148 (1862); Forbes in Bothalia 3: 122 (1930). Lectotype: 'In dunis prope nemora ante sylvas primaevas in Krakakamma (Uitenhage)', *Ecklon s.n.* (S, lectotype; K, L, S, *SAM 49205* isotypes).

19. Otholobium polystictum *(Benth. ex Harv.) C.H. Stirton,* comb. nov.

Psoralea polysticta Benth. ex Harv. in Harv. & Sond., Fl. Cap. 2: 150 (1862); Phillips in Ann. S. Afr. Mus. 16: 80 (1917); Jacot Guillarmod, Fl. Lesotho 194 (1971). Holotype: Doornkop, Winburg district, Orange Free State, *Burke s.n.* (K).

Lotodes polystictum (Benth. ex Harv.) O.K., Gen. Pl. 3,2: 65 (1891).

20. Otholobium racemosum *(Thunb.) C.H. Stirton,* comb. nov.

Psoralea racemosa Thunb. Prodr. 135 (1800); Fl. Cap. 607 (1823); Poir. in Lam., Method. 696 (1804); DC., Prodr. 2: 218 (1825); Walp., Repert. 1:657 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 151 (1862); Forbes in Bothalia 3: 135 (1930). non E. Mey., Comm. 87 (1836). Holotype: 'é Cap. Bon. Spei', *Thunberg s.n.* (UPS — *Thunb. 17581*, seen on microfiche).

P. hilaris Eckl. & Zeyh., Enum. 230 (1836); Walp., Repert. 1: 658 (1842). Lecotype: 'Inter gramina montium in Langekloof (George)', *Ecklon s.n.* (S, lectotype; S, SAM, TCD, isotypes).

21. Otholobium rotundifolium *(L.f.) C.H. Stirton,* comb. nov.

Psoralea rotundifolia L.f., Suppl. Pl. 338 (1782); Thunb., Prodr. 135 (1800); Fl. Cap. 605 (1823); Harv. in Harv. & Sond. 2: 155 (1862); Forbes in Bothalia 3: 129 (1930). Lecotype: 'Habiat in Cap. Bonae Spei', *Thunberg s.n.* (UPS — *Thunb. 17583*, microfiche). There are no specimens of this species in LINN, S, or BM (Hort. Cliff.).

22. Otholobium sericeum (Poir.) *C.H. Stirton,* comb. nov.

Psoralea sericea Poir. in Lam. Method. 5: 687 (1804); DC., Prodr. 2: 218 (1825); Meisn. in J. Bot., Lond. 2: 81 (1843); Drège in Linnaea 19: 645 (1846); Presl, Bot. bemerk. 60 (1844). Holotype: Without precise locality, *Sonnerat s.n.* (P).

Rhynchodium sericeum Presl, Bot. Bemerk. 60 (1844).

Psoralea tomentosum Thunb., Prodr. 2: 135 (1800) non Cav. (1795); DC., Prodr. 2:218 (1825); Harv. in Harv. & Sond, Fl. Cap. 2: 156 (1862).

P. pedunculata Ker-Gawl in Bot. Register t.223 (1817) non Poir. (1816) nec Vaill. (1891); Meisn. in J. Bot., Lond. 2: 81 (1843).

Eriosema capitatum E. Mey., Comm 130 (1836); Meisn. in J. Bot., Lond. 2: 81 (1843); Presl, Bot. Bemerk. 60 (1844); Harv. in Harv. & Sond. 2: 262 (1862). Lectotype: 'Ad fluvium Ruigtervallei in fruticetis', *Drège s.n.* (K, lectotype; GBH, PRE, isotypes).

Rhynchosia cephalotes Steud. Nom. 2,2: 588 (1841).

23. Otholobium spicatum *(L.) C.H. Stirton,* comb. nov.

Psoralea spicata L., Mant. alt. 264 (1771); Thunb., Fl. Cap. 307 (1823); E. Mey. in Linnaea 7: 166 (1832); E. Mey., Comm. 86 (1836); Eckl. & Zeyh., Enum. 229 (1836); Richter, Codex 739 (1840); Walp., Repert. 1: 657 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 154 (1862); Forbes in Bothalia 3: 134 (1930); Adamson & Salter, Fl. Cape Penins. 487 (1950). Type: 'Habitat in Cap. b. spei campis', collector unknown. There are no specimens of this species in S. Three specimens exist in LINN (*928.6* in Linnaeus's hand; *928.7* and *928.8* both determined in L.f's hand and probably incorporated after 1771. *Thunberg 17584* in UPS belongs to this species. As I am unable to lectotypify this species I am choosing the following neotype. Neotype: 3 km from Heidelberg to Riversdale, 9-12-1981, *Stirton 10256* (K).

P. spicata sensu Poiret in Lam., Method. 686 (1804) is *Otholobium striatum* (Thunb.) C.H. Stirton.

24. Otholobium stachyerum *(Eckl. & Zeyh.) C.H. Stirton,* comb. nov.

Psoralea stachyera Eckl. & Zeyh., Enum. 230 (1836); Walp., Repert. 1: 657 (1842). Lectotype: 'In locidis et pratensibus ad fluminis ripam Zwartkopsrivier', *Ecklon & Zeyher s.n.* (S, lectotype; K, isotype).

25. Otholobium striatum *(Thunb.) C.H. Stirton,* comb. nov.

Psoralea striata Thunb., Fl. Cap. 608 (1823); DC., Prodr. 2: 218 (1825); E. Mey., Comm. 87 (1836); Forbes in Bothalia 3: 136 (1930). Holotype: 'crescit prope Dornrivier in Carro pone Bokkeveld', *Thunberg s.n.* (UPS — *Thunb. 17586*, seen on microfiche).

P. eckloniana Otto, nom. nud. This name is cited in the literature and is found on older herbarium specimens in European herbaria. I cannot trace it in the literature.

P. spicata sensu Poir (1804) non L. (1771).

P. rupicola Eckl. & Zeyh., Enum. 230 (1836). Holotype: 'Inter saxa in Karro prope flumen Gauritzrivier (Swellendam)', *Zeyher s.n.* (S).

26. Otholobium thomii *(Harv.) C.H. Stirton,* comb. nov.

Psoralea thomii Harv., Fl. Cap. 155 (1862); Forbes in Bothalia 3: 129 (1930). Lectotype: Cape, without precise locality, *Thom 697* (K). Syntype: 'CBS', *Bowie s.n.* (K).

27. Otholobium trianthum *(E. Mey.) C.H. Stirton,* comb. nov.

Psoralea triantha E. Mey., Comm. 88 (1836); Walp., Repert. 1: 658 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 150 (1862); Forbes in Bothalia 3: 123 (1930); Adamson & Salter, Fl. Cape Penins. 487 (1950). Lectotype: 'Locis humidis ad Bergrivier', *Drège s.n.* (K, lectotype; BM, BOL, P, isotypes). Syntype: I have not come across any of the following syntypes: 'In collibus prope Lauwskloof', *Drège s.n.*; 'In arenosis ad Breederivier', *Drège s.n.*; 'in fruticetis ad Zwartkopsrivier', *Drège s.n.*

P. triflora Poir. in Lam., Encycl. 5: 683 (1804) non Thunb. (1800). Poiret cites specimens from Herb. Juss. and from Herb. Lam. His concept of the species is confused and seems to combine elements of *O. candicans* (Herb. Juss.) and *O. trianthum* (Herb. Lam. and Herb. Juss.).

28. Otholobium uncinatum *(Eckl. & Zeyh.) C.H. Stirton,* comb. nov.

Psoralea uncinata Eckl. & Zeyh., Enum. 231 (1836); Forbes in Bothalia 3: 120 (1930); Adamson & Salter, Fl. Cape Penins. 488 (1950). Lectotype: 'Tulbagh', *Zeyher s.n.* (S, lectotype; K, L, S, SAM, isotypes).

P. cephalotes E. Mey., Comm. 87 (1836) non Eckl. & Zeyh. (1836). Syntypes: 'Inter Simonsberg et Tygerberg', *Drège s.n.* (K, S); 'Klein Draakenstein', *Drège s.n.* (K). The latter specimen is *Otholobium bracteolatum* (Eckl. & Zeyh.) C.H. Stirton.

P. hirta L. var. *jacquiniana* sensu E. Mey. in Linnaea 7: 165 (1832) non DC. (1825).

29. Otholobium venustum *(Eckl. & Zeyh.) C.H. Stirton,* comb. nov.

Psoralea venusta Eckl. & Zeyh., Enum. 231 (1836); Walp. 1: 658 (1842); Harv. in Harv. & Sond., 2: 155 (1862); Forbes in Bothalia 3: 134 (1930). Holotype: 'Saldanha Bay', *Ecklon & Zeyher s.n.* (S). I have only found a single specimen that bears the printed Eckl. & Zeyh. label.

30. Otholobium wilmsii *(Harms) C.H. Stirton*, comb. nov.

Psoralea wilmsii Harms in Bot. Jahrb. 26: 286 (1899); Forbes in Bothalia 3: 136 (1930); Burtt Davy., Ferns & Flowr. Pl. Trans. 374 (1932). Holotype: near Lydenburg, *Wilms 295* (Z holotype; K, isotype).

31. Otholobium zeyheri *(Harv.) C.H. Stirton,* comb. nov.

Psoralea zeyheri Harv., Thes. Cap. 1: 15, t.80 (1859); Harv. in Harv. & Sond., Fl. Cap. 2: 156 (1862); Forbes in Bothalia 3: 132 (1930). Holotype: Twenty-four Rivers, *Zeyher 2375* (K, holotype; K, PRE, S, SAM, TCD, W, isotypes).

The following species have been treated previously (Stirton 1981b, 1982, 1983):

32. Otholobium caffrum *(Eckl. & Zeyh.) C.H. Stirton* in Adv. Leg. Syst. 341 (1981).

Psoralea caffra Eckl. & Zeyh., Enum. 230 (1836); Walp., Repert. 1: 657 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 155 (1862); Forbes in Bothalia 3: 133 (1930); Lectotype: 'In collibus graminosis inter flumine Katrivier et Keyrivier', *Ecklon s.n.* (S, lectotype; K, L, isotypes).

P. royffei Forbes in Bothalia 3: 136 (1930). Holotype: Cala, Tembuland, *Royffe 61* (GRA).

P. caffra in Eckl. & Zeyh. of Trauseld, Wildflow. Natal Drakensberg 103, photo on p. 102 (1969), is *Otholobium fumeum* C.H. Stirton mss.

33. Otholobium rubicundum *C.H. Stirton* in Jl S. Afr. Bot. 49: 337 (1983).

Holotype: Hoeko Road, south base of Klein Swartberg Mountains, *Wurts 1606* (NBG). When I described this species I confused the collector T.M. Wurts with Barker who had named the specimen. The collector is here corrected to Wurts.

34. Otholobium pictum *C.H. Stirton* in Jl S. Afr. Bot. 49: 340 (1983).

Holotype: Baviaanskloof Mountains, between Smitskraal and Wilgehof, *Oliver 4588* (STE, holotype; BM, K, PRE, isotypes).

35. Otholobium pungens *C.H. Stirton* in Bothalia 14: 72 (1983).

Holotype: Potberg North, *Acocks 22835* (K, holotype; PRE, isotype).

New species

36. Otholobium swartbergense *C.H. Stirton,* sp. nov.; a *O. sericeum* (Poir.) C.H. Stirton foliis parvioribus, ellipticis, floribus paucibus differt.

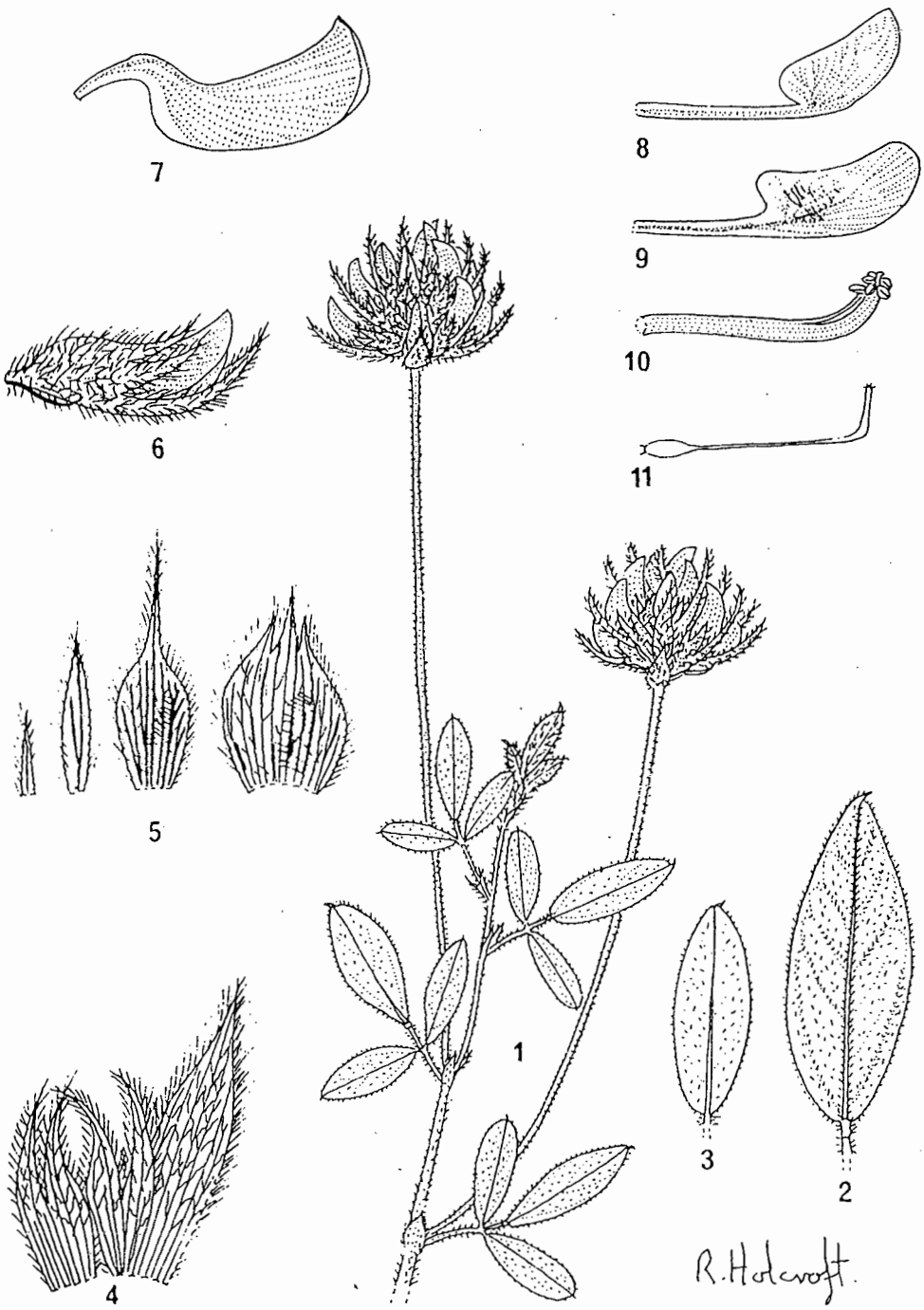

Figure 1 *Otholobium swartbergense* 1. Flowering shoot, × 1; 2. terminal leaflet, × 2; 3. lateral leaflet, × 2; 4. calyx opened out, × 3; 5. flowering bracts, showing variation from setaceous terminal bract to the lowest positioned flabellate bract, × 4; 6. side view of the flower just prior to opening, × 3; 7. standard, × 4; 8. keel, × 4; 9. wing petal, × 4; 10. androecium, × 4; 11. pistil, × 4.

Frutex parvus, effusus, aromaticus. *Folia* trifoliolata. *Foliola* 15 — 22 mm longa, (4)6 — 8(11) mm lata, plana, elliptica, pubescentia, valde recurvato-mucronata, basi obtusa; lateralia breviora. *Inflorescentia* floribus 6 – 15, axillaris. *Flores* 8 – 11 mm longi, malvini, purpurascentes. *Dentes* calycis inaequales. *Alae* carina longiores.

TYPUS. — Cape Province: Oudtshoorn, Swartberg Pass, northern slopes below summit, *Stirton 10310* (PRE, holotypus; BOL, K, MO, NBG, NH, STE, isotypi).

Small spreading shrublet. *Stems* slender, numerous, covered in short appressed upwardly pointing hairs with longer patent hairs interspersed and dominant on angles. *Leaves* trifoliolate. *Stipules* 5 – 7 mm long, 1,8 – 3,0 mm wide, ovate to shortly oblong, apex acute; glabrous inside, sericeous outside. *Petioles* (3)5 – 7(9) mm long, hairy, fused to stipules at the base. *Leaflets* 15 – 22 mm long, (4)6 – 8(11) mm wide (the larger leaves being produced later in the season), flat, entire, elliptical, sericeous but denser below especially along veins; base obtuse, apex strongly recurved-mucronate; laterals smaller than the terminal leaflet. *Inflorescences* 6 – 15-flowered, axillary, hemispherical on long peduncles comprised of 2 – 4(5) sets of flowers in triplets, lowest set subtended by a 2 – 3-toothed flabellate bract; bracts gradually narrowing in remaining sets; filiform bractlets subtending each flower. *Flowers* 8 – 11 mm long, mauve becoming purple with age, enclosed within the calyx at anthesis, but standard reflexing partially; pedicel 1,5 – 2,0 mm long. *Peduncle* (50)90 – 120(200) mm long. *Calyx* 11 – 13 mm long; lobes unequal, upper four teeth equal, narrowly triangular, curved, 5,5 – 6,0 mm long, 1,5 – 2,0 mm wide, keel tooth 9 – 10 mm long, 3,0 – 3,5 mm wide; veins prominently reticulate; tube 2,5 – 3,0 mm long. *Standard* 8 – 10 mm long, 5,0 – 6,5 mm wide, obovate, slightly reticulate, narrowed towards the 3 mm long claw. *Wing petals* 9,5 – 10,0 mm long, blade 6 – 7 mm long, 2,2 – 2,5 mm wide, longer than the keel, auriculate, sculpturing upper basal and left central, comprised of 15 – 18

irregular parallel lamellae. *Keel blades* 8 mm long, 2 mm wide; apex rounded, blotched purple on inner face. *Androecium* 8 mm long, vexillar stamen 7,5 mm long, loosely attached to the sheath for half its length. *Pistil* 8 mm long; ovary 1,5 mm long, sparsely glandular, subsessile; style glabrous, height of curvature 2 mm, flexure thickened, stigma papillose. *Seed* and fruit unknown (Figure 1).

Otholobium swartbergense was first collected by Harry Bolus in December 1904. Since then it has been collected about once every decade. It appears to have been missed by many of the collectors who have ritually stopped and lunched at the top of the Swartberg Pass. This is not too surprising as the plant is difficult to find even when it is flowering.

This species has been confused with *O. sericeum* in the herbarium, but when both are seen in the field the differences in habit, size, smell, flower colour, ecological preference and geographical location are decisive and I have no hesitation in describing it as new. They are undoubtedly related and I shall discuss their affinities and distribution in my monograph of the Psoraleeae of Africa.

O. swartbergense is a distinctive endemic of the Groot Swartberg Mountains. It flowers during November and December. The plants are recorded by collectors as growing amongst short grass on rocky outcrops. However, in 1981 and 1984 the only plants that I could find here were growing along the edge of the roadside beneath the crumbling margin of the left-hand roadbank as one descends from the top of the Swartberg Pass to the Forest Station below.

Specimens examined

— **3322** (Oudtshoorn): Northern slopes of Groot Swartberg Mountains (– CC), 12-1904, *Bolus 11476* (BOL, NH, PRE); 1-12-1977, *Bond 1257* (SAAS, STE); 25-1-1941, *Esterhuysen 4563* (BOL); 13-11-1938, *Hafström & Acocks 707* (PRE); 12-12-1981, *Stirton 10310* (BOL, K, NBG, NH, PRE, STE); 12-1943, *Stokoe 9025* (BOL); 11-1945, *Stokoe 59576* (SAM); 12-1951, *Stokoe 66078* (PRE, SAM); Southern side of Swartberg Pass (– CC), 3-11-1928, *Gillett 2002* (PRE, STE); 19-12-1967, *Grobbler 754* (PRE); 2 km below summit on southern side of Swartberg Pass (– CC), 10-11-1971, *Taylor 8286* (STE).

Acknowledgements

I would like to thank the Curators of the following herbaria for the generous loan of herbarium material: BOL, K, NH, PRE, SAAS, SAM, STE and TCD. I am also very grateful to my wife Jana Žantovská who accompanied me and helped me find *O. swartbergense* in the field in 1981.

References

MEISNER, C., 1843. Flora of South Africa. Leguminosae. *Hooker's London Journal of Botany* 2: 60 – 105.

NORDENSTAM, B., 1980. The herbaria of Lehmann and Sonder in Stockholm, with special reference to the Ecklon and Zeyher collection. *Taxon* 29: 279 – 291.

STIRTON, C.H., 1981a. Studies in the Leguminosae — Papilionoideae of southern Africa. *Bothalia* 13: 317 – 325.

STIRTON, C.H., 1981b. Psoraleeae. In: Advances in Legume Systematics, eds. Polhill, R.M. & Raven, P. Royal Botanic Gardens, Kew, Surrey. pp. 337 – 343.

STIRTON, C.H., FIELD, D.V., BRUMMITT, R.K. & McNEILL, J. 1981c. Principles of lecotypification. *Taxon* 30: 251 – 256.

STIRTON, C.H., 1982. A new species of *Otholobium* in South Africa. *Bothalia* 14: 72 – 73.

STIRTON, C.H., 1983. Two new species of *Otholobium* (Fabaceae). *Jl S. Afr. Bot.* 49: 337 – 342.

WIJNANDS, D.O., 1983. The Botany of the Commelins. Balkema, Rotterdam.

APPENDIX 6

Published paper No 4

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Bothalia 13, 3 & 4: 317–325 (1981)

Studies in the Leguminosae — Papilionoideae of southern Africa

C. H. STIRTON*

ABSTRACT

Six African species of *Psoralea* are transferred to *Cullen* Medik.: *C.* **biflora** (Harv.) C. H. Stirton, *C.* **holubii** (Burtt Davy) C. H. Stirton, *C.* **drupacea** (Bunge) C. H. Stirton, *C.* **jaubertiana** (Fenzl) C. H. Stirton, *C.* **obtusifolia** (DC.) C. H. Stirton and *C.* **plicata** (Del.) C. H. Stirton. *Psoralea patersoniae* Schonl. based on an introduced garden plant is placed under synonomy of *Cullen corylifolia* (L.) Medik. The following new names are published: *Lebeckia* **waltersii** C. H. Stirton of subgenus Plecolobium C. H. Stirton; *Bituminaria* **bituminosa** (L.) C. H. Stirton of subgenus *Bituminaria* and *B.* **acaulis** (Stev.) C. H. Stirton of subgenus Christevenia Barneby ex C. H. Stirton; *Rhynchosia* **arida** C. H. Stirton; *Eriosema* **gunniae** C. H. Stirton, *E.* **preptum** C. H. Stirton and *E.* **transvaalense** C. H. Stirton. *Eriosema capitatum* E. Mey. is placed in synonomy with *Psoralea tomentosa* Thunb., but as *P. tomentosa* Thunb. is a later homonym of *P. tomentosa* Cav. it should be referred to *P. sericea* Poir.

RÉSUMÉ

ÉTUDES SUR LES LEGUMINOSAE-PAPILIONOIDEAE D'AFRIQUE AUSTRALE

Six espèces africaines de Psoralea *sont transférées à* Cullen *Medik.:* C. **biflora** *(Harv.) C. H. Stirton,* C. **holubii** *(Burtt Davy) C. H. Stirton,* C. **drupacea** *(Bunge) C. H. Stirton,* C. **jaubertiana** *(Fenzl) C. H. Stirton,* C. **obtusifolia** *(DC.) C. H. Stirton et* C. **plicata** *(Del.) C. H. Stirton.* Psoralea patersoniae **Schonl.** *basée sur une plante de jardin introduite est placée sous la synonymie de* Cullen corylifolia *(L.) Medik. Les nouveaux noms suivants sont publiés:* Lebeckia **waltersii** *C. H. Stirton et du sous-genre* **Plecolobium** *C. H. Stirton,* Bituminaria **bituminosa** *(L.) C. H. Stirton du sous-genre* Bituminaria *et* B. **acaulis** *(Stev.) C. H. Stirton du sous-genre* **Christevenia** *Barneby ex C. H. Stirton;* Rhynchosia **arida** *C. H. Stirton,* Eriosema **gunniae** *C. H. Stirton,* E. **preptum** *C. H. Stirton et* E. **transvaalense** *C. H. Stirton.* Eriosema capitatum *E. Mey. est placé en synonymie avec* Psoralea tomentosa *Thunb., mais comme* P. tomentosa *Thunb est un dernier homonyme de* P. tomentosa *Cav. il devrait se référé à* P. sericea *Poir.*

CONTENTS

INTRODUCTION

This paper is the first in a series of notes on the taxonomy of the Leguminosae — Papilionoideae for the Flora of Southern Africa series. Included also are nomenclatural changes that appertain to floras lying beyond this area.

1. CULLEN Medik.

Recent investigations have shown that the South African representatives of *Psoralea* L. sensu Forbes (1930) should be rearranged into the genera *Psoralea* L., *Otholobium* C. H. Stirton and *Cullen* Medik. (Stirton, 1980). *Psoralea* L. emend. C. H. Stirton is now restricted to 17 Cape species. The new genus *Otholobium* comprises about 28 species widespread over the southern and eastern parts of southern Africa, with one species extending as far north as Kenya. New combinations will be made in *Otholobium* once the complicated nomenclatural problems have been resolved. The remaining seven African species of *Psoralea* L. sensu Hutch. are here transferred to *Cullen* Medik. The Asian and Australasian material of *Cullen*, comprising over 40 species, falls outside the scope of this investigation.

1. **Cullen biflora** (*Harv.*) *C. H. Stirton*, comb. nov.

Psoralea biflora Harv., Fl. Cap. 2: 157 (1862). Type: South Africa, *Burchell* 1720 (K, holo.!)

2. **Cullen corylifolia** (*L.*) Medik, in Vorles, Churpf. Phys.-Oek. Ges. 2: 380 (1787).

Psoralea corylifolia L. Sp. Pl. 764 (1753). Type: India, Herb. Linn. 928. 24 (LINN, holo.!).

Psoralea patersoniae Schonl. in Rec. Albany Mus. 3:54 (1914). Type: South Africa, Redhouse, *Paterson* 383 (K, holo.!) syn. nov.

3. **Cullen drupacea** (*Bunge*) *C. H. Stirton*, comb. nov.

Psoralea drupacea Bunge in Arb. Nat. Ver. Riga 221 (1847). Type: U.S.S.R., between Buchara and Samarkand, *Lehmann* s.n. (LE, not seen).

4. **Cullen holubii** (*Burtt Davy*) *C. H. Stirton*, comb. nov.

Psoralea holubii Burtt Davy, Fl. Transv. 2: XXIX (1932). Type: South Africa, Matebe, *Holub* s.n. (K, holo.!).

5. **Cullen jaubertiana** (*Fenzl*) *C. H. Stirton*, comb. nov.

Psoralea jaubertiana Fenzl in Flora 26: 392 (1843). Type: Syria, between Aleppo and Orfar, *Kotschy* (not seen).

6. **Cullen obtusifolia** (*DC.*) *C. H. Stirton*, comb. nov.

Psoralea obtusifolia DC., Prodr. 2: 221 (1825). Type: South Africa, *Burchell* 1214 (P, holo.!; K, iso.!).

7. **Cullen plicata** (*Del.*) *C. H. Stirton*, comb. nov.

Psoralea plicata Del., Fl. Egypt. 252, t. 27, fig. 3 (1812). Type: between Qournah and Medynetabou, *Delile* s.n. (MPU, not seen).

Psoralea odorata Blatt. & Halb. in J. Bombay nat. Hist. Soc. 26: 238 (1918). Type India, Jodhpore, Barmer, *Blatter* 7005 (K, holo., photo.!).

2. BITUMINARIA Heist. ex Fabricius

Psoralea bituminosa L. and *P. acaulis* Stev. are two widely cultivated species of *Psoralea L.* sensu lato. The recent decision to confirm the subdivision

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of *Psoralea L.* into a number of genera (Stirton, 1980) has made it necessary to search for a generic name to accommodate them, the name *Psoralea* now being reserved for some 17 species of plants endemic to the southern tip of Africa. Most authors have used *Aspalthium* Medik (1787) as a segregant generic name to accommodate *P. bituminosa* whenever it was thought to be distinct from *Psoralea* (e.g. Meikle 1977). According to Dandy (1967), however, the name *Bituminaria* Heist. ex Fabricius (1759) is a synonym of *Psoralea* sensu lato. It predates *Aspalthium* and becomes available. There is however some controversy about selecting Fabricius generic names based on Heister's works. Some authors such as Holub (1970) and Rauschert (1968) consider Fabricius's generic names to be uninomials and invalidly published. Dandy (1967) and Stafleu & Cowan (1976) disagree with this considering that the typographical distinction of the uninomials clearly distinguishes them as generic names. Fabricius (Enum, 1759), however, consistently distinguishes generic names by capitals. After consulting Dr R. K. Brummitt and Mr R. D. Meikle (Royal Botanic Gardens, Kew) and in view of the conservation of a number of Fabricius's names, I have accepted that *Bituminaria* Heist. ex Fabricius, as the protologue shows, is validly published.

> '*BITUMINARIA* Heister. Trifolium asphaltites f. bituminosum Rpp. & Dod. Psoralea Linn. Planta fere arborescens. Flores spicati pediculo communi longo sustinentur, 3. foliolis in 3. vel. 4 lacinias dissectis 3. utpl. flores ex ala sua emittentibus petiolatos. Perianthum tubulosum quinquefidum, una lacinia maxima. Vexillum purpuro violaceum oblongum sursum et ad latera reflexum in medio faciei internae 2. appendiculis instructum. Alae breviores albae rectae concavae. Carina brevior purpurea anterius, posterius alba obtusa bipetala, reliqua ut in alia trifoliis. Sed fructus sit. legumen compressum rotundo falcatum setosum ultra perianthium prominens, et continens semen unicum magnum figura phaseoli'.

Bituminaria Heist. ex Fabricius comprises two species and is closely related to or may be congeneric with *Pediomelum* Rydb. from North America. Pending further study which may indicate otherwise, I recognize two distinct subgenera: *Bituminaria* and *Christevenia* Barneby ex C. H. Stirton.

Bituminaria *Heist. ex Fabricius,* Enum. 165 (1759); Dandy, Regn. Veget. (1967). Type species: *Bituminaria bituminosa (L.) C. H. Stirton.*

Psoralea L., Sp. Pl. 1: 762 (1753), pro parte.

Aspalthium Medik. Vorles. in Churpf. Phys.-Oek. Ges. 2: 380 (1787).

Key to subgenera

Plant caulescent; leaflets entire; peduncles axillary (Mediterranean Europe and Macaronesia) . . . . subgen. *Bituminaria*
Plant acaulescent from superficial caudex; leaflets denticulate; penduncles scapiform (north-eastern Turkey and W. Transcaucasus) . . . . . subgen. *Christevenia*

Subgen. **Bituminaria**

Plant perennial, caulescent. *Leaves* pinnately trifoliolate, entire. *Flowers* shortly spicate on elongated axillary peduncles; bracts at each node of the inflorescence united through half their length or more, those at the lower nodes into a flabellate 3(5)-toothed blade, succeeding ones often narrower or the uppermost wanting; calyx ebracteolate. *Fruit* indehiscent, with a long sword-shaped beak which at length breaks off, furnished with glabrous spinulose processes; pericarp adnate to seed.

The single species in this subgenus, *B. bituminosa,* is very distinct yet remarkably variable throughout its range. It has been widely cultivated throughout Europe and to a lesser extent elsewhere. A survey of the available material would indicate that it comprises a number of distinct taxa, some of which are quite localized. This subgenus needs to be investigated anew over its entire range. Particular attention should be paid to floral dissections. *Psoralea morisiana* Pignatti & Metlesics belongs here and may be quite a distinct species. Its status will have to be determined in context of the overall range of *B. bituminosa* (see: Bol. Soc. Sarda Sci. Nat. 15: 53, 1975).

1. **Bituminaria bituminosa** (*L.*) C. H. Stirton, comb. nov. Type: in Siciliae, Italiae, Narbonae collibus maritimis.

Psoralea bituminosa L., Sp. Pl. 1: 763 (1753); Boiss., Fl. Or., 2: 187 (1872); Stuart Thompson in J. Bot., Lond. 44: 306 (1906); Post, Fl. Palest., ed. 2, 1: 367 (1932); Davis, Fl. Turkey, 3: 264 (1970); Zohary, Fl. Palest., 2: 50, t. 66 (1972).

Aspalthium frutescens Medik. in Vorles, Churpf. Phys.-Oek. Ges., 2: 380 (1787); *Aspalthium herbaceum* Medik., l.c. 2: 381 (1787). *Aspalthium bituminosum* (L.) Fourr. in Ann. Soc. Linn. Lyon, ser. 2, 16: 365 (1868); Kuntze in Post & Kuntze, Lex. Gen. Phan., 48 (1903) as *Asphalthium bituminosum;* Meikle, Fl. Cyprus, 1: 489 (1977).

Subgen. **Christevenia** *Barneby ex C. H. Stirton,* subgen. nov.

Planta perennis, acaulis. *Folia* subdigitatim trifoliolata, denticulata. *Flores* capitati, pedunculo elongato scapiformi; bracteae in quoque nodo inflorescentiae usque ad basin distinctae; calyx basi untrinque bracteola lineari instructus. *Fructus* indehiscens, rostro ensiformi processibus mollibus pubescentibus armato.

Type species: *Bituminaria acaulis* (Stev.) C. H. Stirton.

Plant perennial, acaulescent. *Leaves* subdigitately trifoliolate, denticulate. *Flowers* capitate on elongated scapiform peduncles; bracts at each node of the inflorescence separate to the base; calyx furnished at the base, each side with a linear bracteole. *Fruit* indehiscent, with a sword-shaped beak armed with soft pubescent processes.

The single species in this subgenus, *B. acaulis* (Stev.) C. H. Stirton, occurs in north-eastern Turkey and the west Transcaucasus.

2. **Bituminaria acaulis** (*Stev.*) *C. H. Stirton,* comb. nov. Type: in iberia occidentali (W. Georgia).

Psoralea acaulis Stev. ap. Hoffmn. in Comm. Soc. Phys.-mat. Mosq. 1: 47 (1806); M. B. Fl. taur.-Cauc. 2: 206 (1808); Ldb., Fl. Ross. 1: 563 (1842); Boiss., Fl. Or. 2: 187 (1872); Grossg., Fl. Kavk. 2: 291 (1930); Vasil'chenko in Fl. U.S.S.R. 11: 226 (1945), Eng. transl. 1971; Davis., Fl. Turkey 3: 264 (1970). *Aspalthium acaulis* (Stev.) Hutch., Gen. Fl. Pl. 1: 420 (1964).

3. **LEBECKIA** Thunb.

For a number of years an undescribed Cape legume has been circulating under the manuscript name *'Waltersia heleniae'*. The correct generic placement of this undescribed species has remained unresolved ever since it was first discovered and collected by Dr I. B. Walters. It had been variously referred to *Buchenroedera, Wiborgia* and *Lebeckia*. Apart from the collections cited and the one in Dr Walters's per-

sonal herbarium, this species has apparently not been collected by the early collectors. This seems surprising considering the plant's rather distinctive features and, so, notwithstanding its localized distribution, it is to be expected that additional collections may still be found misfiled in undetermined covers among various genera. I have referred it to *Lebeckia* notwithstanding the un-Lebeckia like presence of prominent involucrate stipules. The only other legume in South Africa which I know to have similar stipules is *Argyrolobium involucratum*. The alternative is to describe a new monotypic genus. Such an approach would be somewhat premature until *Lebeckia* and its segregates have been adequately revised and until more is known about this species which I am describing as *Lebeckia waltersii*. This species is easily separated from all other *Lebeckia* species by its unique stipules and plicate pods. I am therefore establishing the subgenus *Plecolobium* to accommodate it. This name refers to the concertina-like pods.

Subgen. **Plecolobium** *C. H. Stirton,* subgen. nov.

Frutices parvi valde ramosi, stipulis conferruminatis petiolo adnatis ramulos omnino vaginantibus. *Fructus* plicati, indehiscentes, modice lignosi.

Type species: *Lebeckia waltersii* C. H. Stirton.

Small profusely branched shrubs with fused stipules adnate to the petiole and completely sheathing the branches. *Fruits* indehiscent, plicate, somewhat woody.

Lebeckia waltersii *C. H. Stirton,* sp. nov., affinitate incerta.

Frutex erectus ramosisimus 50–60 cm altus. *Stipulae* conferruminatae petiolo adnatae, ramulos omnino vaginantes. *Folia* trifoliolata, argentea; foliola 4–10 mm longa, usque 2 mm lata, subsessilia, aequalia, anguste obovata, curvata, conduplicata. *Inflorescentia* 1–3-flora, axillaris. *Flores* 10 mm longi, pedicello 3–5 mm longo. *Calycis* dentes tubo breviores, lobis vexillaribus maxime fissis, tenuiter pubescentes. *Vexillum* 8,6 mm longum, usque 9,5 mm latum, unguiculatum, dorso sericeum. *Petala* alaria carinalibus subaequilonga. *Pistillum* 10–11-ovulatum; ovarium sericeum. *Stamina* monadelpha, axialiter usque ad basin fissa, antheris dimorphis. *Stigma* minutum. *Fructus* plicatus. *Semina* reniformia, late brunnea.

TYPE.—CAPE, 3319 (Worcester): Worcester Commonage (–CB), *Rourke 1484* (K, holo.!).

Erect much-branched shrub 50–70 cm high. *Stipules* fused and wholly adnate to the petiole and completely sheathing branches, becoming bifurcate in leaves that subtend inflorescences, sericeous. *Leaves* trifoliolate, very shortly petiolate. *Leaflets* 4–10 mm long, 1,5–2,0 mm wide, subsessile, equal in size, narrowly obovate, somewhat recurved, base cuneate, apex obtuse, conduplicate, rarely flattened, sericeous. *Inflorescences* axillary, 1–3-flowered, borne on short lateral branches. *Flowers* 10 mm long, bright yellow (less yellow than in *L. cytisoides,* however), each subtended by a very small erect bract, ebracteolate; pedicel 3–5 mm long. *Calyx* 4 mm long; triangular teeth shorter than the 3 mm tube, vexillar lobes less connate than lateral and keel lobes; finely pubescent outside, glabrous inside. *Standard* 8,5 mm long, up to 9,5 mm wide, claw 3 mm long, broadly ovate, auricles and appendages absent, apex emarginate, back silky. *Wing* petals 10,5 mm long, 4,0 mm wide, claw 3 mm long, cultrate, sparsely pubescent, equal in length to keel; sculpturing upper basal and left central, finely lamellate-lunate; auriculate. *Keel* petals fused, 9,5 mm long, 3,5 mm wide, somewhat pubescent. *Pistil* 7–8 mm long; ovary 5 mm long, subsessile, flattened and most hairy above and below, sparsely laterally, style erect, glabrous, height of curvature 2,5–3,0 mm; stigma minute, very finely penicillate. *Stamens* monadelphous, sheath split adaxially; anthers dimorphic, basifixed anthers narrowly ovate and 2,5 mm long, dorsifixed anthers rounded and 1,3 mm long. *Fruit* 15–20 mm long, 4–5 mm wide, plicate, indehiscent, somewhat woody, persisting on the plant for more than a year. *Seeds* 3 mm wide and long, reniform, greenish brown. 2n = 32 (count by Christine Brighton, Jodrell Laboratories, Kew). Fig. 1.

Lebeckia waltersii is endemic to the south-western Cape (Fig. 2) and is found growing in renosterbosveld on Table mountain sandstone conglomerate in association with *Pteronia* and *Elytropappus*. Flowering occurs in July.

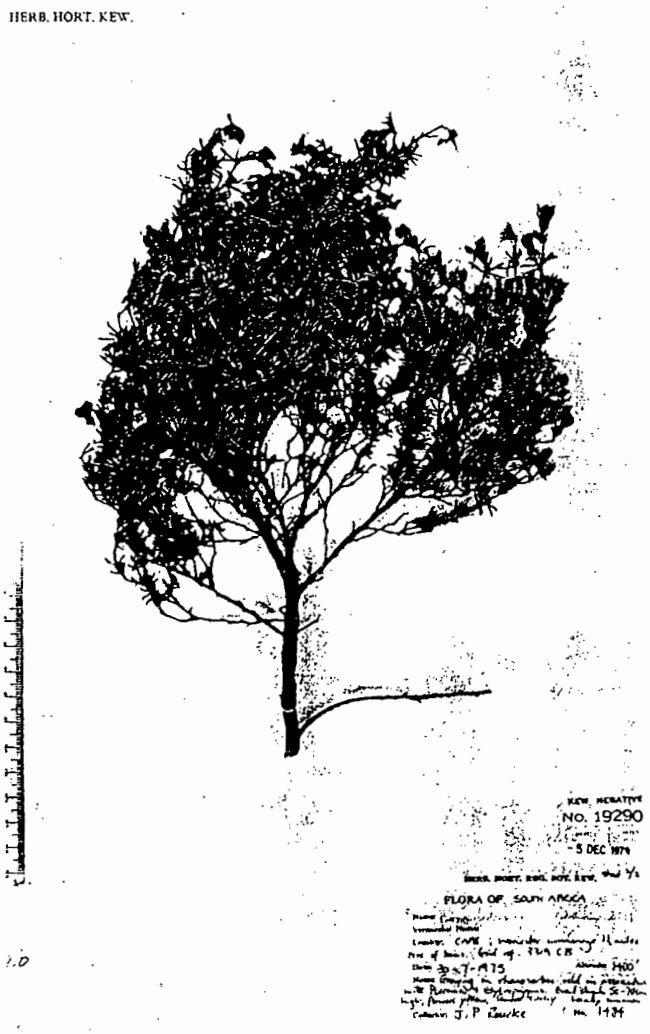

FIG. 1.—*Lebeckia waltersii. Rourke* 1484, holotype in K.

CAPE.—3319 (Worcester): Worcester (–CB), *Rourke 1484* (K; NBG; PRE); *Esterhuysen 35048* (K; BOL); *Walters s.n.* (NBG, Herb. Walters).

Hutchinson 253 (K) collected between Vredenburg and Hoetjies Bay may be conspecific with *Lebeckia waltersii*. It may even represent another species. It has overall a similar appearance to *Rourke* 1484 but differs in its non-conduplicate, wider leaves, more than 1-flowered inflorescence, less prominent stipule

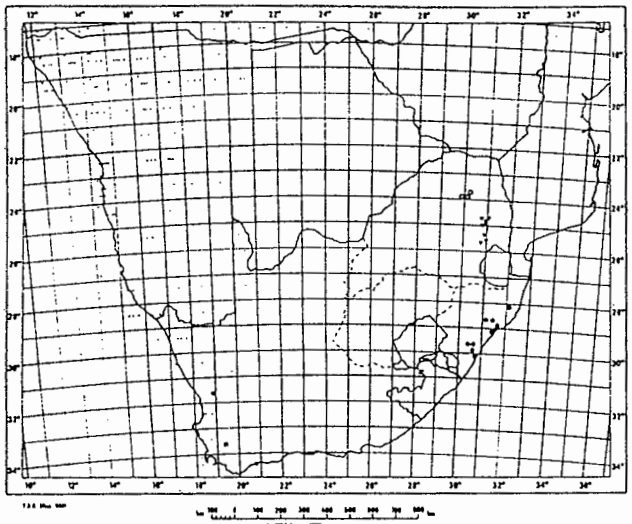

FIG. 2.—Known distribution in southern Africa of *Lebeckia waltersii* (■), *Rhynchosia arida* (★), *Eriosema gunniae* (▼), *E. preptum* (●) and *E. transvaalense* (○).

scars and disjunct distribution. I have included it tentatively under *L. waltersii* as it fits no where else. It had been incorrectly named *Wiborgia sericea* Thunb. *Hutchinson* 253 is without fruits, which are required for a firm decision. I have seen no further collections of it.

L. waltersii is an attractive shrub which, with its mass bloom of small yellow flowers, should delight gardeners. There is a very real danger however that this species may become extinct unless the citizens of Worcester, its locality, take concerted action to ensure its protection. It is limited to probably only some ± 60 individual plants divided into a few colonies (Walters, 1980, pers. comm.) Perhaps Worcester could adopt it as their town flower? If other towns and villages throughout the country similarly adopted a rare or endangered species specific to their area perhaps much could be done to ensure the adequate protection and propagation of many species of plants across the length and breadth of South Africa.

The specific epithet *waltersii* is given in recognition of the determined campaign that Dr I. B. Walters of Worcester has waged in ensuring that *L. waltersii* was at least named before it disappeared! It is now up to the citizens of Worcester.

4. **RHYNCHOSIA** Lour.

Rhynchosia arida *C. H. Stirton,* sp. nov., affinitate incerta.

Frutex deciduus usque 1 m altus et latus verne florens; ramuli virgati, puberuli et sparsim glandulosi. *Folia* trifoliolata; foliola ovata vel elliptica, apice uncinata, basi truncata, 10–20 mm longa, 9–13 mm lata, atrovirentia; lateralia inaequalia, basi obliqua, terminali symmetrico breaviora; supra puberula, infra glabrescentia, in utroque superficie glandulosa. *Stipulae* subulatae, glandulosae. *Petioli* 9–13 mm longi. *Racemi* axillares, 2–4-flori, foliis longiores; pedunculus 13–20 mm longus. *Flores* lutescentes, 14–16 mm longi; bractea 4–5 mm longa, caduca, leviter navicularis. *Calyx* 15–16 mm longus, inaequaliter lobatus, sparsim pilosus, glandulis magnis basi bulbosis conspicue tectus; tubus 5 mm longus; lobus carinalis ceteris longior, lanceolatus, acuminatus; lobi laterales falcati; lobi cornuti per dimidium longitudinis conferruminati. *Vexillum* unguiculatum, 11–12 mm longum, 10 mm latum, late ovatum, glabrum et eglandulosum, vix reflexum, carina brevius sed alis longius, callis leviter evolutis et bene supra parvas auriculas sitis. *Alae* glabrae, 10–11 mm longae, carina breviores, marsupio evoluto, auricula bene evoluta, sculptura secus cristam marsupii leviter evoluta, lamellatae. *Carina* glabra, laminis 13 mm longis, usque 7–8 mm latis, basi curvatis, apice obtusis, marsupioevoluto. *Vagina* staminalis 12–13 mm longa, stamine discreto 14 mm longo, antheris uniformibus, filamentorum breviorum medifixis, longiorum basifixis, dehiscentia longitudinali. *Gynoecium* 13 mm longum, ovarium 4 mm longum, cum gyophoro 1 mm longo; pubescentia brevi, patente; curvatura 5 mm alta; stigma capitatum, ultra stamina exsertum. *Nectarium* 0,4–0,6 mm altum, margine undulato. *Legumina* 3–4 cm longa, 1 cm lata, falcata, lignosa, margine undulato, subtiliter pubescente. *Semina* ignota.

TYPE.—Cape, 3118 (Vanrhynsdorp), Mount Matsikamma (–DB), *Acocks 15125* (K, holo.; PRE, iso.!).

Deciduous shrub up to 1 m high and broad, flowering in spring; branchlets virgate, puberulous and sparsely glandular. *Leaves* trifoliolate; leaflets ovate or elliptic, apex uncinate, base truncate, 10–20 mm long, 9–13 mm wide, dark green; laterals unequal-sided, oblique at base, smaller than symmetrical terminal leaflet; puberulous above, glabrescent below, glandular on both surfaces. *Stipules* subulate, glandular hairy. *Petioles* 9–13 mm long. *Racemes* axillary, 2–4-flowered, longer than leaves, peduncle 13–20 mm long. *Flowers* yellow, 14–16 mm long; bracts 4–5 mm long, caducous, slightly boat-shaped. *Calyx* 15–16 mm long, unequally lobed, sparsely pilose, conspicuously covered with large bulbous-based glands; tube 5 mm long; keel lobe longest, lanceolate, acuminate, laterals falcate, vexillar lobes fused for half their length. *Standard* unguiculate, 11–12 mm long, 10 mm wide, broadly ovate, glabrous, eglandular, scarcely reflexed, shorter than keel but longer than wings, appendages weakly developed and situated well above small auricles. *Wings* 10–11 mm long, glabrous, shorter than keel, pocket present, auricle well developed, sculpturing weakly developed along ridge of pocket, lamellate. *Keel blades* 13 mm long, 7–8 mm wide at maximum, glabrous, incurved, apex obtuse, pocket present. *Staminal sheath* 12–13 mm long, free stamen 14 mm long, anthers uniform, medifixed and basifixed, dehiscence longitudinal. *Gynoecium* 13 mm long, ovary 4 mm long with gynophore 1 mm long; clothed with short patent pubescence; curvature 5 mm high; stigma capitate, exerted beyond stamens. *Nectary* 0,4–0,6 mm high, margin undulate. *Fruits* 3–4 cm long, 1 cm wide, falcate, woody, upper margin undulate, finely pubescent. *Seed* unknown. Fig. 3.

It is now over thirty years since the first and only specimen of this species was collected in semi-succulent karoo along the lower slopes of Mt Matsikamma (Fig. 2). *R. schlechteri* Bak., *R. bullata* Benth. ex Harv., *R. ferulaefolia* Benth. ex Harv., *R. pinnata* Harv. and *R. viscidula* Steud. are the only species of *Rhynchosia* that are distributed in Mediterranean areas of the Cape and are therefore outliers in an essentially subtropical genus. These rare, unrelated species, including *R. arida,* are endemic to the Cape. All have narrow disjunct distributions with few relatives elsewhere in the genus.

The specific epithet *arida,* meaning *becoming dry,* is in reference to the semi-succulent karoo vegetation

FIG. 3.—*Rhynchosia arida*. *Acocks* 15125, holtype in K.

in which the species grows. As far as I know, *R. arida* is the only *Rhynchosia* which is restricted to this habitat.

5. PSORALEA L.

Eriosema capitatum E. Mey., Comm. 130 (1836), was treated by Harv., Fl. Cap. 2: 262 (1862), as a species unknown. A close study of the protologue shows that *E. capitatum* cannot be an *Eriosema*.

> 'Caule erecto antrorsum appresso pubescentes canescentes, folioliiss lanceolato-oblongo utrinque acutiusculis subtus incano-sericeis, *capitulis subglobosis involucratis longe pedunculatis* (italics mine)'.

There is no species of *Eriosema* in South Africa which has an involucrate subglobose flower-head. Furthermore, the type locality Ruigtervallei falls outside the distribution range of *Eriosema*. The protologue does, however, indicate features that might suggest *Psoralea* L.

A study of the literature indicates that *E. capitatum* should be placed in synonomy under *Psoralea tomentosa* Thunb., a distinctive Cape species. A problem arises, however, in that *P. tomentosa* Thunb., Prodr. 2: 135 (1800), is a later homonym of *P. tomentosa* Cav., Icon. 3: 21, t. 240 (1795), a validly described species from Mexico, now accepted as *Dalea tomentosa* (Cav.) Willd. The earliest available name for *P. tomentosa* Thunb. is *P. sericea* Poir.

Psoralea sericea *Poir.*, Dict. 5: 687 (1804); in DC., Prodr. 2: 218 (1825); Meisn., in J. Bot., Lond. 2: 81 (1843); Drège, in Linnaea 19: 645 (1846); Presl, Bot. Bemerk. 60 (1844).

Rhynchodium sericeum Presl, Bot. Bemerk 60 (1844).

Psoralea tomentosa Thunb., Prodr. 2: 135 (1800) non Cav. (1795); in DC., Prodr. 2: 218 (1825); Harv., Fl. Cap. 2: 156 (1862).

P. pedunculata Ker-Gawl. in Bot. Register t. 223 (1817) non Poir. (1816) nec Vail. (1891); Meisn., l.c. 2: 81 (1843).

Eriosema capitatum E. Mey., Comm. 130 (1836) syn. nov.; Meisn., l.c. (1843); Presl, Bot. Bemerk. 60 (1844); Harv., l.c. 2: 262 (1862).

Rhynchosia cephalotes Steud. Nom. 2, 2:588 (1841), syn. nov.

6. ERIOSEMA G. Don

1. **Eriosema gunniae** *C. H. Stirton*, sp. nov., *E. cordato* E. Mey. affinis, a qua imprimis ramulis floriferis erectis brevioribus, floribus luteis et bracteis persistentibus aequantibus differt.

Herba perennis, 10–15 cm alta, verne florens. *Rami* erecti, pilis velutinis dense obtecti. *Folia* pro maxima parte 1-foliolata; 6–9 cm longa, 2,5–3,0 cm lata anguste elliptica vel anguste ovata usque lanceolata, apice acuta, cuneata, utrinque (sed praecipue in nervaturis) sericeo-pubescentia, glandulosa, margine aliquantum revoluto. *Stipulae* 15–20 mm longae, lanceolatae, coalitae, glandulosae et pilosae. *Petioli* 10–20 mm longi. *Racemi* axillares, 10–15-flori, foliis aequilongi; pedunculus 6–9 cm longus. *Flores* lutescentes, 8–10 mm longi; bracteae ± 8 mm longae, persistentes. *Calyx* 5–7 mm longus, lobis aequalibus, pilis stramineis patentibus usque 2,5 mm longis dense obtectus, tubo 2 mm longo; lobi deltoidei, acuminati, lobus carinalis longior, laterales falcati, lobi cornuti non coaliti. *Vexillum* 9–10 mm longum, 4,5–5,5 mm latum, unguiculatum, reflexum, obovatum, extra glandulosum et pilosum, carina et alis longius; calli bene evoluti, conferruminati cucullati, ab auriculis prominentibus liberi. *Alae* 8,5–9,0 mm longae, 2,0–3,2 mm latae ad maximum, oblongae, auriculatae, carina longiores. *Carina* glandulosa et pilosa, laminis 6–7 mm longis, 3 mm latis ad maximum, marsupio evoluto. *Vagina* staminalis 5,5–6,0 mm longa, stamine discreto 5,4–6,0 mm longo, antheris uniformibus. *Gynoecium* 5 mm longum, ovarium 2,5 mm longum, cum gynophoro 0,5 mm longo, longe pubescens; curvatura 2,0 mm alta; stigma capitatum, ultra stamina exsertum. *Nectarium* evolutum, margine revoluto. *Legumina* et semina matura non visa.

TYPE.—Transvaal, 2530 (Lydenburg): Witklip Forest Research Station (–BD), *Stirton 1482* (PRE, holo.!).

Perennial herb, 10–15 cm tall, flowering in spring. *Stems* erect, densely covered with straw-coloured hairs. *Leaves* mostly 1-foliolate, 6–9 cm long, 2,5–3,0 cm wide, narrow-elliptic to narrow-ovate to lanceolate, apex acute, base cuneate, both sides sericeous especially along veins, glandular; margin somewhat revolute. *Stipules* 15–20 mm long, lanceolate, fused, glandular and hairy. *Petioles* 10–20 mm long. *Racemes* axillary, 10–15-flowered, equalling leaves, peduncle 6–9 cm long. *Flowers* yellow, 8–10 mm long. bracts ± 8 mm long persistent. *Calyx* 5–7 mm long, lobes equal, triangular, acuminate, keel lobe longest, laterals falcate, vexillar lobes free. *Standard* 9–10 mm long, 4,5–5,5 mm wide, clawed, reflexed, obovate, glandular and hairy, longer than keel and wings; appendages well developed, fused and hooded, free from prominent auricles. *Wings* 8,5–9,0 mm long, 2,0–3,2 mm wide at maximum, oblong, auriculate, longer than keel. *Keel* blades 6,0–7,0 mm long, 3 mm wide at maximum, glandular and hairy, pocket present. *Staminal sheath* 5,5–6,0 mm long, free stamen geniculate, 5,4–6,0

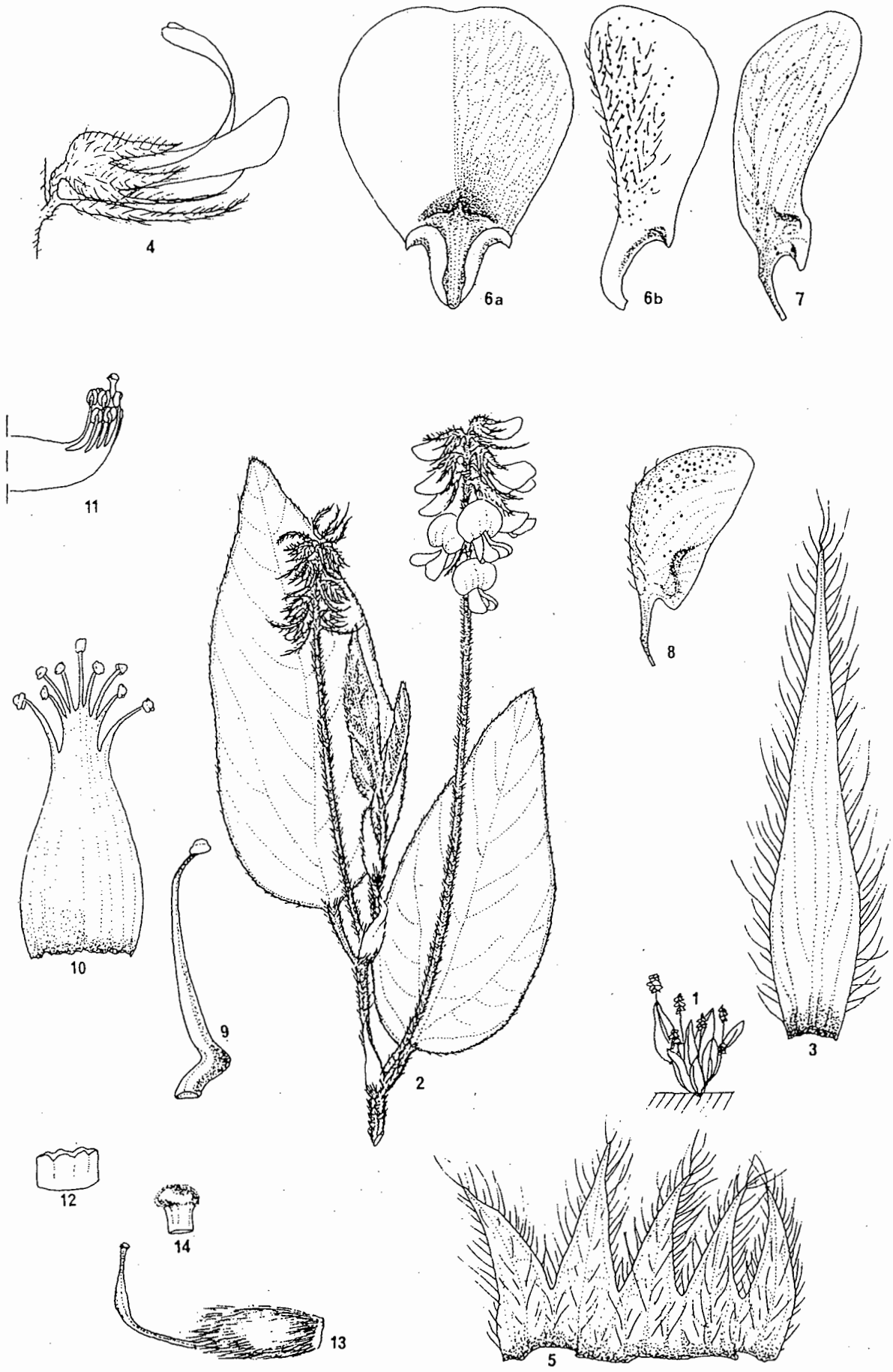

FIG. 4.—*Eriosema gunniae*. 1, habit; 2, stem with flowers, × 0,5; 3, flower bract, × 7,5; 4, flower, × 2,3; 5, calyx opened out, × 5,3; 6a, standard opened out, × 3,8; 6b, standard closed, × 3,8; 7, wings, × 3,8; 8, keel, × 3,8; 9, vexillar stamen, × 5,3; 10, staminal sheath, × 5,3; 11, staminal sheath closed with stigma and portion of style exserted, × 5,3; 12, discoid floral nectary, × 15; 13, gynoecium, × 5,3; 14, stigma, × 33.

mm long; anthers uniform. *Gynoecium* 5 mm long; ovary 2,5 mm long with 0,5 mm gynophore, densely covered with long hairs, curvature 2,0 mm high; stigma capitate, exerted beyond stamens. *Nectary* present; margin revolute. *Mature fruits* and seeds not seen. Fig. 4.

Restricted to the eastern Transvaal between Pilgrims Rest, Graskop, Witklip, Sudwala and Nelshoogte (Fig. 2). This species is found on undisturbed grassy plateaux. It grows commonly in association with another rare legume, *Rhynchosia villosa* (Meisn.) Druce.

TRANSVAAL.—2430 (Pilgrims Rest): Pilgrims Rest (–DD), *Rogers 14908;* Graskop (–DD), *Galpin 14580 Holland s.n.* 2530 (Lydenburg): Witklip Forest Research Station (–BD), *Stirton 1482;* pass above Sudwala Caves (–DB), *Grobbelaar 1439;* Nelshoogte (–DB), *Muller 2157.*

Eriosema gunniae was first collected near Pilgrims Rest in 1915. It has been commonly referred to *E. cordatum,* but can be distinguished by its stigma exserted from the staminal sheath and by its persistent flower bract that approximates the length of the flower. Four collections are included temporarily in *E. gunniae: Young* A72 from Middelburg, *Young* A214 from Susterstroom, *Rudatis* 2513 from Tautesberg and *Grobelaar* 1675 from Steenkampbergen. This composite group occurs to the west of the range of *E. gunniae* sensu stricto. Further collections from the intervening areas may enable their correct status to be decided.

This distinctive *Eriosema* is named in honour of Miss Mary Gunn, who was a recipient of the 1976 Bolus Medal for outstanding achievement in the field of botany by an amateur botanist (see Veld & Flora 62: 30 – 31, 1976). Her knowledge of botanical literature and plant collectors has been of great importance to both South African plant taxonomy and taxonomists alike.

2. Eriosema preptum *C. H. Stirton,* sp. nov., affinitate incerta.

Herba perenna erecta 20–60 cm alta, flore vernale. *Caules* 1–15, pilis albis brevibus trichomatibusque longioribus interspersis vestiti. Caudex stylopodio longo, gracilis moniliformis iuventute, aetate undulescens vel constringescens sed dauciformescens. *Folia* trifoliolata raro infima unifoliolata (nunc vulgo obovata), 4,5–6,0 cm longa, 2,0–3,0 cm lata, lateralia minora asymmetrica, elliptica vel anguste obovata, apice subacuto, basin versus cuneata, sparse pubescentia, infra dense lanata, venibus prominentibus ob indumentum densum trichomatibus longioribus appressis, glandularia, marginibus revolutis. *Stipulae* 8–14 mm longae, libri. *Racemi* axillares, (8–) 25–35 florati ut pseudospicae congestae, folia subtendentia superantes. *Flores* 6–7 mm longi, ad 3 mm lati, aurantiaci venis rubribus vel croceo-aurantiacis, bractei 6 mm longi, cito caduci. *Lobi* calycis aequales, triangulares, tubam aequantes. *Vexillum* 6–7 mm longum, obovatum, appendix praesens connata, per summum unquem de auriculo in auriculum extensa; dorsum pubescens, glandulare. *Petala carinae* breviora quam alae. *Gynoecium* dense pubescens. *Fructi* 10–12 mm longi, 8 mm lati, molliter sericei. *Semini* grisei vel pallide brunnei, guttati vel maculati.

TYPE.—Natal, 2930 (Pietermaritzburg): Scottsville, Pietermaritzburg (–CB), *Stirton 1242* (PRE, holo.; K, iso.).

Perennial herb, erect, 20–60 cm tall, spring flowering. *Stems* 1–15, clothed in short white hairs with longer hairs interspersed. *Rootstock* with long stylopodium, thin and beaded when young but becoming wavy or constricted but carrot-like when mature. *Leaves* 3-foliolate, rarely the lowest leaves 1-foliolate (then mostly obovate), 4,5–6,0 cm long, 2,0–3,0 cm wide, laterals smaller and asymmetrical, elliptic to narrowly obovate, apex subacute, base cuneate, sparsely pubescent above, densely woolly below with veins prominent due to dense covering of longer appressed hairs, glandular, margins revolute. *Stipules* 8–14 mm long, free. *Racemes* axillary, (8–) 25–35 flowered in congested pseudo-spikes, overtopping the subtending leaves. *Flowers* 6–7 mm long, up to 3 mm wide, orange with red veins or yellow-orange; bracts 6 mm long, rapidly caducous. *Calyx* teeth equal, triangular, ± equal to calyx tube. *Standard* 6–7 mm long, obovate, appendage present, fused, extending across top of the claw from auricle to auricle, back hairy and glandular. *Keel petals* shorter than wing petals. *Gynoecium* densely hairy. *Fruits* 10–12 mm long, 8 mm wide, softly sericeous. *Seeds* grey or light brown, with speckles or blotches. Fig. 5.

Eriosema preptum is endemic to Natal (Fig. 2) and extends some 100 km inland from the coastal belt. In the past it has been consistently called *E. squarrosum,* an unrelated Cape species. The nature of this confusion will be dealt with in detail in a subsequent paper on the *Eriosema squarrosum* complex. This species favours sandy sites along roadsides and ditches but is also commonly found in grassland.

NATAL.—2831 (Nkandla): Nkwaleni River Valley (–CB), *Codd 1839;* 18 km from Eshowe to Ginginghlovu (–DC), *Stirton 1297.* 2832 (Mtubatuba): Hluhluwe Game Reserve (–AA), *Scott-Smith 10.* 2930 (Pietermaritzburg): Pietermaritzburg (–CB), *Stirton 368, 1139, 1242, 1410;* 5 km from Table Mountain to Pietermaritzburg (–DA), *Stirton 1032;* near mid-Illovo (–DC), *Stirton 1114.* 2931 (Stanger): 43 km from Stanger to Mtunzini (–AB), *Stirton 407, 1001, 1002;* near Compensation (–BA), *Stirton 1160.* 3030 (Port Shepstone): 8 km from Eston to Winkelspruit (–BB), *Stirton 1122.*

3. Eriosema transvaalense *C. H. Stirton,* sp. nov., *E. cordato* E. Mey. affinis, sed floribus minoribus, pubescentia, florum colore seminibus differt.

Herba perenna ad 15 cm alta, flore vernale. *Caules* multi, implexi, prostrati vel decumbentes, basi ramificantes, subtiliter pubescentes pilis flavescentibus reflexis. *Folia* trifoliolata, infima semper unifoliolata, 3,5–6,5 cm longa, 2,5–3,5 cm lata rotundata vel ovata, ellipticescentia, ambo superficies virides, subtiliter pubescentes; ima venatione prominente elevata. *Stipulae* semiconnatae. *Rhachis* 3–4 mm longa. *Racemi* 6–8 florati, foliolos superantes. *Flori* laeti rosei flavique, 9–10 mm longi, 3 mm lati, bracteo ad 5 mm longo. *Calyx* 6 mm longa, lobi tubam subaequitantes. *Vexillum* 9 mm longum, 6 mm latum, obovatum, subcucullatum; dorsum tomentosum glandulare; appendices praesentes, supra unquem, connatae et ad auriculos leniter evolutos extensae. *Petala carinae* dense glandulares. *Gynoecium* 6 mm longum, ovarium dense pubescens. *Fructus* 15–16 mm longus, 10 mm latus, oblique oblongus rostro 2 mm longo, molliter flavo-pubescens, glandularis. *Semen* 5–6 mm longum, 3 mm latum, castaneum purpureomaculatum.

TYPE.—Transvaal, 2329 (Pietersburg): near Ebenezer Dam (–DD), *Stirton 1438* (PRE, holo.; K, iso.).

Perennial herb, up to 15 cm tall, spring flowering. *Stems* many, matted, prostrate or decumbent, branching at the base, finely pubescent with reflexed yellowish hairs. *Leaves* 3-foliolate, with lower leaves

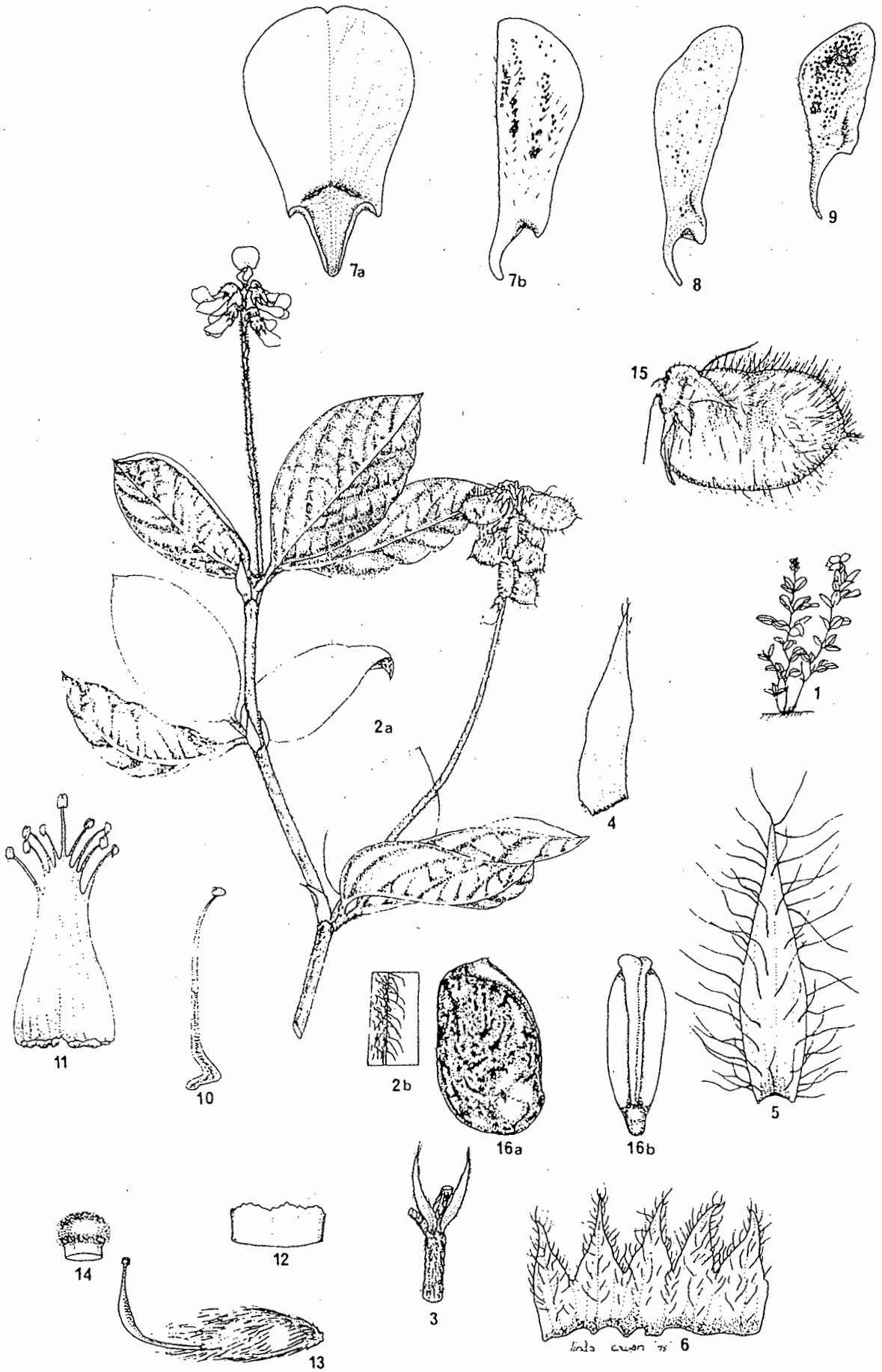

FIG. 5.—*Eriosema preptum*. 1, habit; 2, stem with fruits and flowers, × 0,5; 2b, stem vesture, × 4; 3, node showing free stipules, × 3,3; 4, stipule, × 2,3; 5, flower bract, × 7,5; 6, calyx opened out, × 5,3; 7a, standard opened out, × 3,3; 7b, standard closed, × 3,3; 8, wing, × 3,3; 9, keel, × 3,3; 10, vexillar stamen, × 5,3; 11, staminal sheath, × 5,3; 12, discoid floral nectary, × 15; 13, gynoecium, × 5,3; 14, stigma, × 33; 15, fruit, × 2; 16a, seed with strophiole, face view, × 5,3; 16b, seed with strophiole, marginal view showing hilum, × 5,3.

always 1-foliolate, 3,5–6,5 cm long, 2,5–3,5 cm wide, rounded to ovate, becoming elliptic, both surfaces green, finely pubescent above and below, lower surface with prominent raised venation. *Stipules* semi-connate. *Rhachis* 3–4 mm long. *Racemes* 6–8 flowered, overtopping leaflets. *Flowers* pale pink and yellow, 9–10 mm long, 3 mm wide, bract up to 5 mm long. *Calyx* 6 mm long, teeth ± equal to tube. *Standard* 9 mm long, 6 mm wide, obovate, somewhat hooded, back tomentose, glandular; appendages present, above the claw, fused and extending to weakly developed auricles. *Wing petals* 9 mm long, longer than keel, prominent peg present which fits tightly into the pocketed keel, sparsely glandular and hairy. *Keel petals* densely glandular. *Gynoecium* 6 mm long; ovary densely pubescent. *Fruit* 15–16 mm long, 10 mm wide, obliquely oblong with 2 mm long beak, softly yellow pubescent, glandular. *Seed* 5–6 mm long, 3 mm wide, chestnut brown with purple flecks. Fig. 6.

This species was collected for the first time as recently as five years ago and is endemic to isolated populations in the Magoebaskloof-Haenertsberg region (Fig. 2). *E. transvaalense* hybridizes with *E. angustifolium* Schinz. It grows in open grassland and is particularly evident along firebreaks.

TRANSVAAL.—2329 (Pietersburg): near Ebenezer Dam (–DD), *Stirton 1438*. 2330 (Tzaneen): Magoebaskloof Hotel (–CB), *Stirton 1445*.

FIG. 6.—*Eriosema transvaalense*. *Stirton* 1438, holotype in PRE.

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UITTREKSEL

Ses Psoralea-*spesies van Afrika word na* Cullen *Medik. oorgedra:* C. **biflora** (*Harv.*) *C. H. Stirton,* C. **holubii** (*Burtt Davy*) *C. H. Stirton,* C. **drupacea** (*Bunge*) *C. H. Stirton,* C. **jaubertiana** (*Fenzl*) *C. H. Stirton,* C. **obtusifolia** (*D.C.*) *C. H. Stirton en* C. **plicata** (*Del.*) *C. H. Stirton.* Psoralea patersoniae *Schonl., gebaseer op 'n ingevoerde tuinplant, word as 'n sinoniem onder* Cullen corylifolia (*L.*) *Medik. geplaas. Die volgende nuwe name word gepubliseer:* Lebeckia **waltersii** *C. H. Stirton van die subgenus* **Plecolobium** *C. H. Stirton;* Bituminaria **bituminosa** (*L.*) *C. H. Stirton van die subgenus* Bituminaria *en* B. **acaulis** (*Stev.*) *C. H. Stirton van die subgenus* **Christevenia** *Barneby ex C. H. Stirton;* Rhynchosia **arida** *C. H. Stirton;* Eriosema **gunniae** *C. H. Stirton,* E. **preptum** *C. H. Stirton en* E. **transvaalense** *C. H. Stirton.* Eriosema capitatum *E. Mey. word as 'n sinoniem onder* Psoralea tomentosa *Thunb. geplaas, maar aangesien* P. tomentosa *Thunb. 'n latere homoniem van* P. tomentosa *Cav. is, moet dit na* P. sericea *Poir. verwys word.*

REFERENCES

DANDY, J. E., 1967. Index of generic names of vascular plants 1753–1774. *Regn. Veg.* 51: 1–130.

FORBES, H. M. L., 1930. The genus *Psoralea* Linn. *Bothalia* 3: 116–136.

HOLUB, J. 1970. *Lamiastrum* versus *Galeobdolen* and comments on problems of unitary designations in Fabricius's work 'Enumerati methodica plantarum horti medici helmstadiensis'. *Folia geobot. phytotax.* 5: 61–88.

MEIKLE, R. D., 1977. *Flora of Cyprus*. Kew: Bentham-Moxon Trust.

RAUSCHERT, S., 1968. Zur frage der Gattungsnamen bei Fabricius. *Taxon* 17: 153–156.

STAFLEU, F. A. & COWAN, A. S., 1976. *Taxonomic Literature*. 1: A—G. Utrecht: Bohn, Scheltema & Holkema.

STIRTON, C. H., 1980. Psoraleeae. In R. Polhill & P. Raven, *Advances in legume systematics*. 329–336. Kew: Royal Botanic Gardens.

APPENDIX 7

Published paper No 5

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PREFACE

Plant systematics has been said by some prominent systematists to be. in a period of sober and mature reflection with no major new developments having taken place in the last few years. Is this really the image of modern systematics or is it just the narrow view of a maturing bandwagon which hasn't recognized the renaissance that is gathering pace?

Most systematists would agree that there is still much to digest and that great swathes of organisms will have disappeared before we can collect, name and classify them. But to extrapolate from this common cause and claim that either the mechanics or the scope of systematics have become moribund is a grave disservice to the profession. Indeed, the 1980's may well turn out to be a watershed, not only for the many technological breakthroughs which have occurred, but also for the many new ideas which have accompanied them.

Systematics in the nineties will be integrated with a new generation of microcomputers which will be as powerful as many of todays mini- and main-frame computers. One is constantly reminded by each new development in microelectronics that not only the way we work is altering but so are the range of questions we are able to ask. Such changes are beginning to make themselves felt and are reflected in some of the systematic papers gathered in this volume. Unfortunately, the revolution in hardware is now far ahead of the provision of specialist software for the systematist. What software there is is either still under development or beta-test, is poorly documented or is so difficult to comprehend or operate that for most people it is effectively unusable. Established software is only just beginning to be linked and the idea of an international data transfer format is only now being addressed. The International community will need to embark on a number of joint international projects with realistic funding if the problem is to be redressed. Such funding will only become available if we sharpen up our image and reverse our low standing in the scientific community. One approach, which would attract and excite a new generation of students, would be the development of an integrated "Systematics Workstation".

The concept of a systematics workstation may be new to some readers. It is simply the equivalent of the electronic "dealing desk" of a stockbroker or the "designer's desk" of a modern graphics studio. Where it differs is in the software and in the greater use of different bits of hardware. My ideal workstation for the nineties would comprise the following hardware and software: 80386-type microcomputer with built-in 1 gigabyte WORM (write once read many) optical disk drive; 20 megabyte RAM (Random access memory); 80387 Maths co-processor; very high resolution, vertical, double A4 size, colour monitor which emulates all known standards; a bank of powerful graphics chips and transputers for parallel processing; a combined FAX (Facsimile), laser printer and document scanner printing in colour at 20 pages per minute at a resolution of 1200 dots per inch; digitizing camera and interfacing card; built in communications modem; spoken word input, and digitizing tablets. Some of these components are already available and are being used by some individual systematists. However, other parts such as the integrated laser are still on the drawing boards or under test but I believe that they will be available by the year 2000 at a price reasonable enough for many individual researchers and most research establishments to own at least one such workstation. But what about the software to run on it?

The available software has not yet been integrated and some modules still need to be written but one might expect a relational database at its core and interfaced via spoken natural language commands through a knowledge based (expert system) front-end which could run a number of programs simultaneously. Such programs would include scientific word-processing, automatic mapping, key and description writing, online identification as well as cladistic and statistic modules. The main working environment would "communicate" with data gathering devices and a desktop publishing package which would be capable of sending merged text and graphics to a laser as final output, to the editor via fax or modem and finally to a typesetting machine. Perhaps the papers for part 4 of this series will be based entirely on documents submitted as text files on floppy disk? In this Part the papers of Crisp and Weston, Zandee and Geesink, Zindler-Frank, Tucker and Kay were provided on disk but because they were written on different microcomputers using different software they needed considerable manipulation before they could be used by the typesetting software. This is a major problem which will need to be addressed in the future.

One of the exciting new areas of research which is only just beginning to establish itself in plant systematics is DNA sequencing. The use of mitochondrial (mtDNA) and chloroplast (ctDNA) DNA's in unravelling the phylogeny of legumes looks particularly promising. As Doyle points out in the first chapter gene sequencing has considerable promise for detecting monophyletic groups. He cautions, however, that as in all potential characters one must consider homoplasies (reversals, convergence and parallelisms). The falling cost and increasing ease of use of these techniques should make them available as routine research tools within a decade. Perhaps the most heartening aspect of this new area of research is that field-collected DNA from vegetative tissues may eventually provide one of the easiest and most cost-effective ways of preserving legume germplasm.

Cladistics has survived and come of age despite the sometimes excessive claims and often acrimonious infighting of some of its early zealots. Perhaps that's what its initial attraction was to a new generation of systematists. It is appropriate therefore that this volume redresses the absence of any cladistic papers in the previous two parts. Crisp and Weston kindly agreed to preface their paper on the cladistics of the tribes Bossiaeeae and Mirbelieae with a broad overview of the basic concepts of the cladistic approach. Some may argue that this is unnecessary as there are now many books devoted to the aims, principles and methods of cladistics. It is my hope, however, that legume researchers who may have wished to try out cladistics before but never did so may find it less intimidating now that there are a number of worked-out examples, for example Lavin's study of Robinieae, which refer to plants and characters with which they are more familiar.

Experienced cladists will probably discuss at some length Zandee and Geesink's general method of cladogram construction and its application to the paraphyletic tribe Millettieae (Tephrosieae). Readers should be aware that their approach is different to that adopted by Crisp and Weston and by Lavin. Their views on the philosophical question as to whether natural taxa are universal classes, or natural kinds, or individuals should stimulate a broader philosophical debate.

It is perhaps significant that the more primitive Millettioid legumes should have caused taxonomists more frustration than more advanced groups. It is clear that some basal tribes of the Papilionoideae such as Sophoreae, Dalbergieae and Millettieae are unnatural groups. It will be a

major task of legume systematists in the years ahead to restructure these groups into monophyletic groups. The task of reclassifying them into a new tribal dispensation should only be undertaken after considerable and detailed analysis and should be discussed critically in the literature before being formalized. We need to anticipate and avoid problems of the type created by the recent incomplete revisions of very large genera such as *Cassia* and *Acacia*.

One of the aims of the Advances of Legume Systematics series will be to publish taxonomic accounts at the tribal and subtribal level. Small's paper brings new data to bear on the tribe Trifolieae; one in which it has been difficult traditionally to delimit the genera. Small erects a new subtribe Trigonellinae, redefines a number of genera and creates a new sectional classification of *Medicago*.

Two subjects addressed in this book concern floral development and embryology. It has long been claimed by cladists that the most valuable data one can have at one's disposal in a phylogenetic study is access to ontogenetic data. The Leguminosae is a large family so it is not surprising to discover that it harbours great diversity of structure and development. Too little is known about the embryology of legumes and meaningful data is so far useful only at the subfamilial level where the three subfamilies differ in the cytology of the anther tapetum, constitution of the micropyle, deposition of starch in the embryo sac and possibly in type of embryogeny. Prakash brings all the literature together in an accessible way and provides the basis for encouraging others to undertake these challenging studies. Tucker's contribution to the comparative developmental morphology of legume flowers is a major contribution to our understanding of the evolution of floral characters in legumes. The implications of her skilfull research to phylogenetic studies will not go unnoticed by the discerning reader.

The studies of Zindler-Frank on calcium oxalate crystals in legumes and of Ferguson on the pollen exine stratification of the Caesalpinioideae underlie the importance of cryptic characters in systematics. Broad surveys of such characters, spread across representatives of as many tribes as possible, reveal suites of features which are neither apparent from an inspection of only part of the whole nor from a random selection of available research material. Ferguson's paper is a critical contribution towards our understanding of pollen infrastructure and how it relates to function and is a step closer to a functional biology of pollen grains. What is needed now is a careful analysis of the different physical and chemical constraints and their interactions which influence the ontogeny and function of pollen.

The comparative structural/functional approach, set in a phylogenetic context and then analysed from a geographic or biological perspective, has been and will continue to be a dominant theme of this series. The value of this approach is seen in Van Staden, Manning & Dickens's paper in which they have been able to suggest, on the restricted data set available, that gibberellins may be important systematically and geographically at the tribal level. Tropical Phaseoleae, for example, produce at least some 3-hydroxylated gibberellins whereas Mediterranean Vicieae do not. By adopting a phylogenetic approach to their work they are pointing the way to other plant physiologists to extend the domain of their research material beyond that of selected crop species. For them it has opened up a new set of questions and has enabled them to discover that there is greater diversity in the physiology of dormancy regulation in legumes than had hitherto been appreciated. More importantly it is offering new insights into how the dormancy of commercial crops may be studied in the future.

Unfortunately their study also highlights the very narrow band of research material from which much of our "fundamental knowledge" about plants has been gathered. As this base broadens I believe that many of our 'well-established' ideas will undergo revision, particularly as more tropical species are investigated.

Just as oxalate crystals and plant hormones are cryptic components of plants so are other aspects of the biology of plants. A good example is that of ultraviolet patterning and ultraviolet-absorbing pigments in flowers of the Leguminosae. Kay has marshalled the available evidence and contributed much new data. He has shown that UV patterning is integrally associated with reproductive biology and that there is great evolutionary and ecological diversification within the family. But much still needs to be done.

A thread that runs through all these papers is that of geography. Yet surprisingly enough there have been very few studies on the phytogeography of legumes. Maslin and Hnatiuk redress this somewhat with a summary of their detailed computer studies of the large genus *Acacia* in Australia. This type of data is needed urgently in legumes as it has a bearing not only on phylogenetics but also as an aid to the discovery of new germ plasm and for the assessment of the conservation status of legumes. The latter subject is poorly developed. It is a measure of our lack of knowledge about the rarity and threatened status of legumes that the Threatened Plants Database of the International Union for the Conservation of Nature (IUCN) has information on only 2668 species of legumes. Hopefully these topics might be major themes at the next International Legume Conference. The importance of geographic information to systematists lies I believe firstly in the unique facility it gives them of plotting character syndromes and then relating the uncovered patterns to ecology and biology and secondly in translating cladograms into area cladograms. Both these aspects of phytogeography should feature prominently in the next decade of legume research.

In conclusion, I believe that we are in the middle of an exciting era of legume research and I hope that the contents of this book and a companion volume on the biology of legumes (Advances in Legume Biology, Missouri Botanical Garden Monograph Series; eds. C. H. Stirton & J. L. Zarucchi) will offer you new insights and useful data.

C. H. Stirton

Kew, 1987.

APPENDIX 8

Published paper No 6

Stirton, C.H. 1982. A new species of *Otholobium* in South Africa. *Bothalia* 14: 72-73.

The genus *Otholobium* C. H. Stirton was erected to accommodate some 40 species of southern and eastern African legumes placed previously in *Psoralea* L. sensu lato (Stirton, Advances in Legume Systematics 1: 337, 1981). Whilst engaged in a nomenclatural investigation of the genus, I came across the following undescribed species.

Otholobium pungens *C. H. Stirton*, sp. nov., *O. decumbenti* (Ait.) C. H. Stirton proximum, sed foliis subdigitatis, pungentibus, nitidis, obovatis, pellucido-glandulosis, calycis lobo carinali pungente, vexillo fere duplo majore diversum.

Frutex lignosus effusus, valde ramosus, caulibus veterioribus nigrescentibus prominenter subgriseo-lenticellatis. *Stipulae* conferruminatae, basi petioli adnatae, late oblique ovatae, margine ciliatae, extra basin versus tenuiter pubescentes, ceterum glabrae. *Folia* petiolata, subdigitata, trifoliolata. *Foliola* 8–10 mm longa, 2,5–3,0 mm lata, lateralia minora, costa excentrica, oblanceolata usque elliptica, basi cuneata, apice pungenti sed raro modice recurvo, nitida, glabra, nisi foliola juniora secus costam marginesque sparse pilosa, glandulis magnis pellucidis sphaericis immersis desuper visis prominentibus sparse obsita. *Inflorescentiae* axillares, 2–3-florae, apicem ramorum versus aggregatae, breviter pedunculatae, bractea obovata dentata 2,5–4,0 mm longa suffultae. *Flores* 9–11 mm longi, 4–5 mm lati, violacei, ebracteolati, bractea lineari 4 mm longa

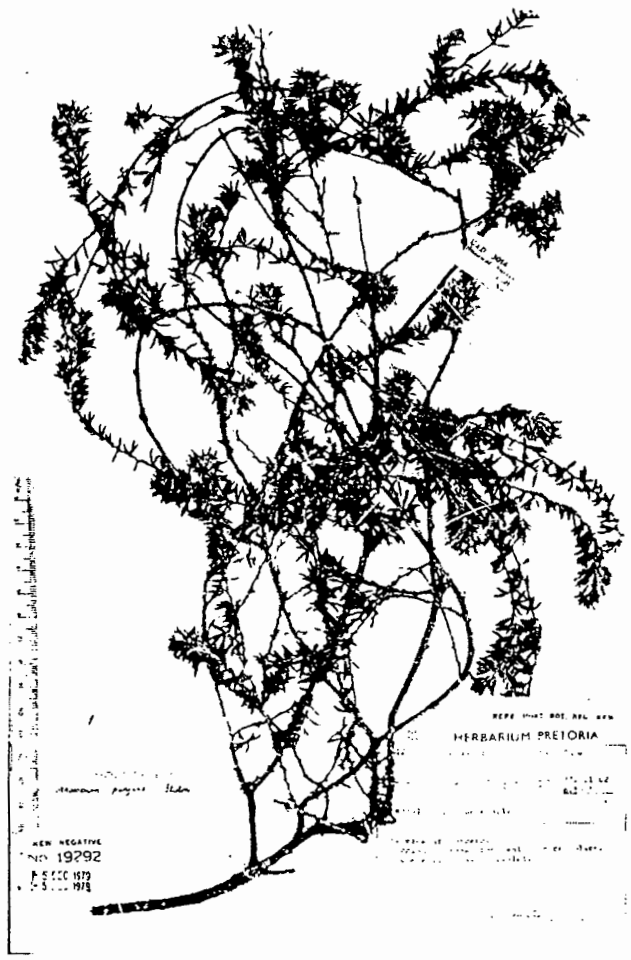

FIG. 7.—*Otholobium pungens*, holotype in K, × 0,3. *Acocks* 22835.

ends of branches, shortly pedunculate, each inflorescence subtended by a 2,5–4,0 mm long, suffulti. *Calycis* dentes tubo longiores, prominenter 3-costati, lobo carinali late ovato glanduloso pungenti excepto omnes lanceolati, lobis vexillaribus haud connatis. *Petala alaria* carina multo longiora. *Ovarium* sessile, 1-ovulatum, glandulis clavatis recurvatis sparse obsitum, stigmate oblique penicillato. *Fructus* et semina ignota.

TYPE.—Cape, 3420 (Bredasdorp): Potberg North (–BC), *Acocks 22835* (K, holo.!). Fig. 7.

Spreading, decumbent, much-branched woody shrub; old branches blackish but puckered with distinctive rectangular bands of grey-white lenticels, glabrous; young branches green, sparsely pilose, finely ribbed. *Stipules* fused, adnate to the base of the petiole, 3–4 mm long, 1,5–2,0 mm wide, broadly and obliquely ovate, acute, striate, glabrous inside, sparingly white pubescent outside towards the base, otherwise glabrous, margins ciliate. *Leaves* trifoliolate, subdigitate, petiolate. *Leaflets* 8–10 mm long, 2,5–3,0 mm wide, oblanceolate, rarely elliptic, base cuneate, apex sharply pungent, rarely recurved, shiny, glabrous except for younger leaves which are sparingly hairy along the midrib and margins, sparingly covered in large spherical internal pellucid glands prominent when seen from above; lateral leaflets smaller, excentric. *Petiole* 2,5–4,0 mm long, petiolules very short. *Inflorescences* axillary, 3- rarely 2-flowered, clustered towards the glabrous toothed, obovate bract with ciliate margins. *Flowers* 9–11 mm long, 4–5 mm wide, light violet, each subtended by a 4 mm long linear bract, ebracteolate. *Calyx* tube 3 mm long, lobes 5 mm long, each tooth prominently 3-ribbed, all lanceolate except the broadly ovate, glandular and pungent keel lobe, hairy along the ribs and on the tube, inner face of teeth finely pubescent. *Standard* 12 mm long, 11 mm wide, broadly-obovate, auriculate, appendages absent, claw 3 mm long, apex emarginate, only sides of the standard reflexed. *Wing petals* 11 mm long, 4 mm wide, cultrate, auriculate, sculpturing upper basal consisting of ± 9 recurved lamellae. *Keel* 7 mm long, 2 mm wide, purple-tipped, shorter than wing petals. *Pistil* 5,5 mm long, glabrous; ovary 3 mm long, 1-ovuled, sessile, sparsely covered with recurved clubshaped glands; style gently upcurved, swollen at point of curvature, height of curvature 2,5 mm; stigma oblique, penicillate. *Vexillar stamen* free, anthers uniform, alternately basifixed and medifixed on long and short filaments respectively. *Fruit* and seed unknown. Fig. 8.

Otholobium pungens appears to be restricted to the transition zone between Mountain Fynbos and Renosterbosveld in the vicinity of Potberg. It occurs commonly in rocky places along the gentle lower slopes of the Potberg.

CAPE.—3420 (Bredasdorp): north of Potberg (–BC), *Acocks* 22835 (PRE; K); *Taylor 7200* (PRE, K, STE); west base of the Potberg (–BC), *Pillans s.n.* (BOL; K).

This distinctive but rarely collected species stands out from all other species of *Otholobium* by its sharply pointed leaves and lower calyx tooth; hence the specific epithet *pungens*.

C. H. STIRTON

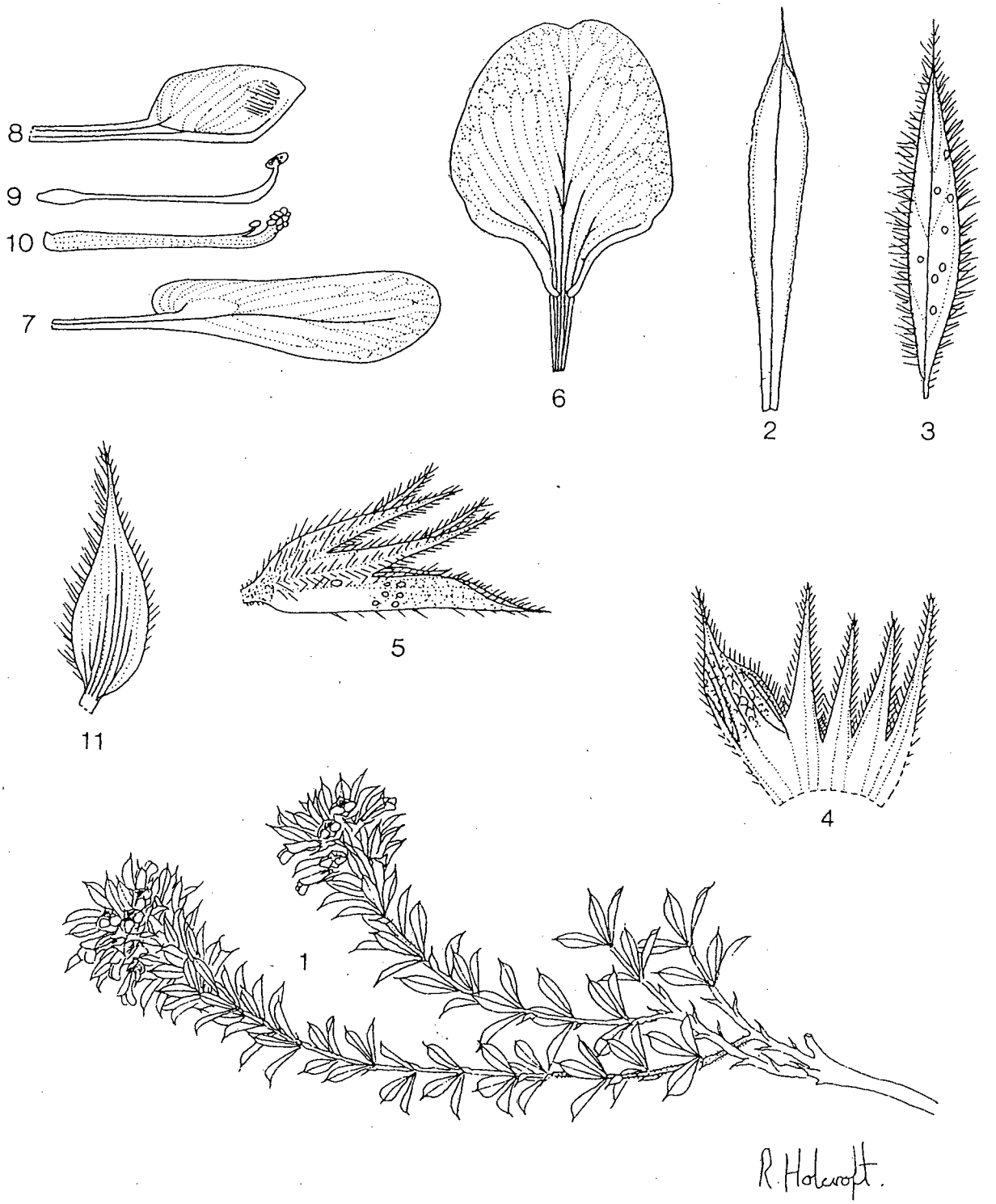

FIG. 8.—*Otholobium pungens*. 1, habit × 1; 2, terminal leaflet, × 6; 3, lateral leaflet, × 6; 4; calyx opened out, × 4; 5, calyx closed, ×4 6, standard opened out, × 6; 7, wing petal, × 6; 8, keel petal, × 6; 9, gynoecium, × 6; 10, androecium, × 6; 11, flower bract, × 10.

APPENDIX 9

Published paper No 7

Stirton, C.H. 1983a. Two new species of *Otholobium* (Fabaceae). *Jl. S. Afr. Bot.* 49: 337-342.

Jl S. Afr. Bot. 49 (4): 337–342 (1983)

TWO NEW SPECIES OF *OTHOLOBIUM* (FABACEAE)

CHARLES STIRTON

(The Herbarium, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AE, England)

ABSTRACT

Two new species of *Otholobium* Stirton are described. One of these, *O. rubicundum* C.H.Stirton, is recorded from the transition belt of Succulent Mountain Scrub and False Macchia on the Klein Swartberg Mountains; and the second, *O. pictum* C.H.Stirton, from the Baviaanskloof Mountains.

UITTREKSEL

TWEE NUWE *OTHOLOBIUM* (FABACEAE) SOORTE

Twee nuwe *Otholobium* Stirton-soorte word beskryf. Een van die soorte, *O. rubicundum* C.H.Stirton, word gevind in die oorgang strook van Sukkulente Bergstruikveld en Skyn-Fynbos op die Klein Swartberge en die tweede, *O. pictum* C.H.Stirton op die Baviaanskloofberge.

Key words: *Otholobium*, sp. nov., Fabaceae, southern Cape, eastern Cape.

Otholobium rubicundum C.H.Stirton, sp. nov.

Frutex parvus, effusus. *Foliola* trifoliolata. *Foliola* 15–25 mm longa, 4–6 mm lata, conduplicata, anguste obovata, glabrescentia, valde recurvato-mucronata, basi cuneata; lateralia breviora. *Inflorescentia* 3–6 flora, axillaris. *Flores* 9–10 mm longi, rosei. *Dentes calycis* aequales. *Vexillum* late ovatum, vix auriculatum, unguiculatum. *Alae* carina longiores.

Type: CAPE—3321 (Ladismith): Hoeko road, south base of Klein Swartberg (-AD), 10/1957, ~~Barker~~ *1606* (NBG, holotype).
T.M. WURTZ

Small spreading shrublet. *Stems* slender, ridged, waxy, sparingly covered with glands and small appressed white hairs. *Flowering shoots* axillary, appressed pubescent with numerous elliptic raised pustules. *Leaves* trifoliolate. *Stipules* 2,5–3,5 mm long, 1,5–2,0 mm wide, triangular; papery, sparingly pubescent but covered with orange-coloured, sunken, rounded glands. *Petioles* < 1 mm long, hairy. *Leaflets* 15–25 mm long, 4–6 mm wide, conduplicate, glabrescent, glandular, narrowly obovate, base cuneate, apex strongly

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recurved mucronate; laterals shorter than terminal leaflet. *Inflorescence* axillary, condensed, comprising 1–2 sets of triplet flowers; each set subtended by a single 3 mm long, 1,5 mm wide, narrowly obovate, acute, hairy and glandular bract. *Flowers* 9–10 mm long, pink; pedicel 2 mm long. *Peduncle* 1–2 mm long. *Calyx* 7 mm long; teeth equal, margins densely ciliate, 4 mm long, upper four teeth 1,7 mm wide, keel tooth 3 mm wide, vexillar teeth slightly connate; lobes prominently glandular, glabrous inside and outside except for a few hairs along the ribs; tube 3 mm deep, ribbed. *Standard* 12 mm long, 8 mm wide, broadly ovate, scarcely auriculate, appendages absent; claw 4 mm long. *Wing petals* 10–11 mm long, 3 mm wide, auricle 1 mm high; sculpturing upper basal and left central comprised of 35–40 parallel lamellae. *Keel blades* 7 mm long, 3 mm wide, blade bulging; claw 3,5 mm long. *Androecium* 7 mm long; vexillar stamen fused to sheath for two-thirds its length. *Pistil* 5,5 mm long; ovary 1,5 mm long, glandular with few hairs, gynophore absent; height of curvature 1,5 mm long; style glabrous 0,5–0,6 mm thick at point of flexure; stigma minutely capitate, finely penicillate. *Fruit* and seed unknown.

Otholobium rubicundum is very rare, having been collected for the first time, as recently as 1957, (by Miss W. F. Barker) This species has not been found since, despite a thorough search by the author in 1980.

Should be T.M. Wurtz

Specimen Examined

Same as for type.

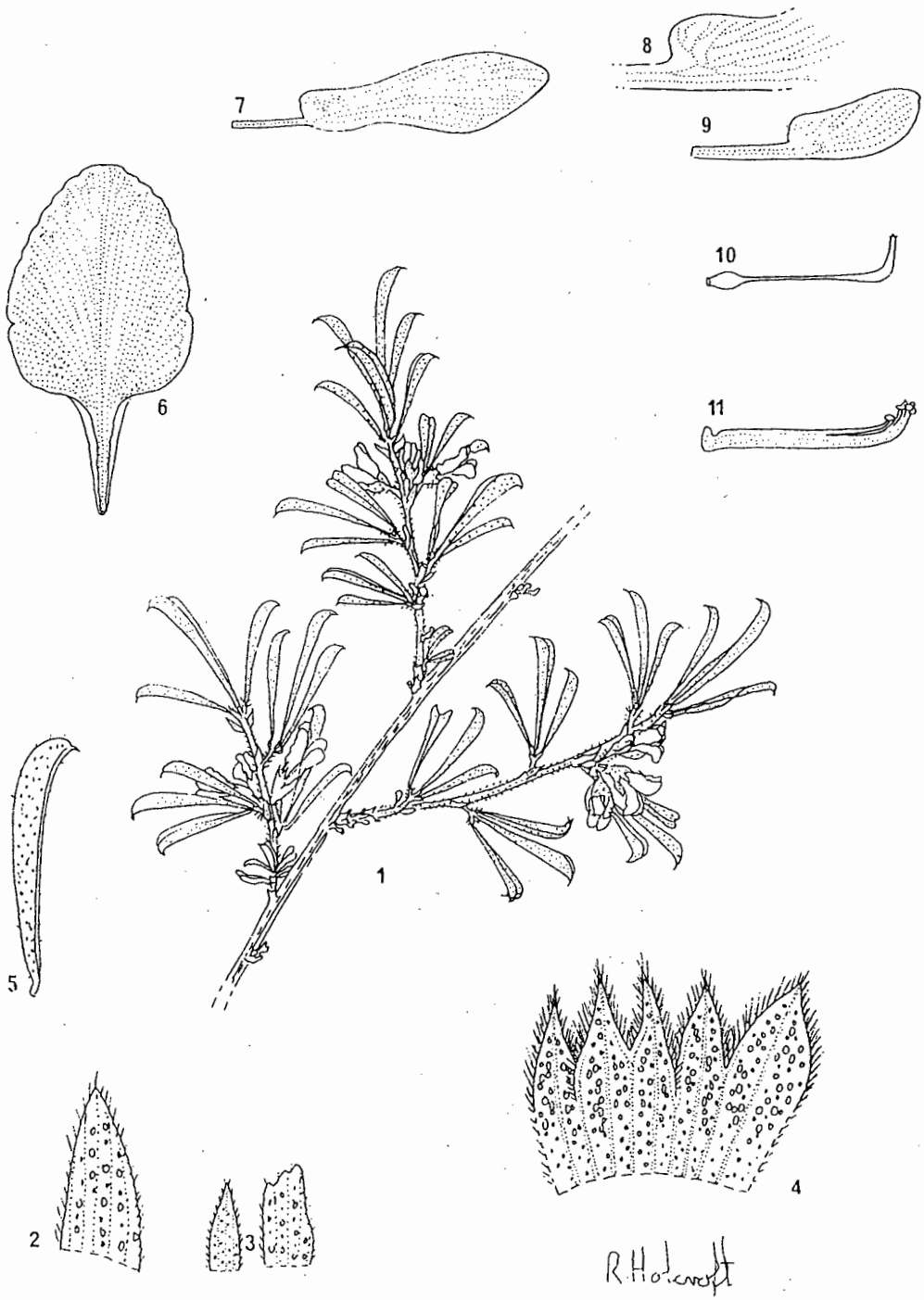
Distribution and Biology

Otholobium rubicundum was found by Miss Barker at an altitude of about 650 m, apparently in the transition belt between False Macchia and Succulent Mountain Scrub vegetation types. Apart from the knowledge that flowering takes place during late October and early November little else is known about the biology of this rare and distinctive shrublet.

Diagnostic Features

Small spreading shrublet; leaflets conduplicate, glandular; inflorescence 3–6-flowered, condensed; flowers pink, each triplet subtended by a narrowly obovate acute bract; standard broadly ovate.

Fig. 1.
Otholobium rubicundum (Barker 1606): 1. Flowering shoots; 2. Stipule; 3. Flower bracts; 4. Calyx opened out; 5. Leaf; 6. Standard; 7. Wing petal; 8. Base of keel; 9. Keel; 10. Pistil; 11. Androecium. (1, × 1; 2–11, × 4.)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R.H.Holcroft

Otholobium pictum C.H.Stirton, sp. nov.

Frutex erectus usque 2 m altus. *Rami* luteo-fusci. *Folia* trifoliolata. *Foliola* 15–25 mm longa 2,5–3,0 mm lata plana, anguste obovata atque aliquantum falcata, prominente nigropunctata, recurvata, mucronata, basi cuneata, lateralia minoria. *Inflorescentia* 60–90-flora, dense spicata, late ovata vel oblonga. *Flores* 9–10 mm longa, albi. *Calycis dentes* inaequales lobus carinae ceteris lobis 2 mm longior. *Vexillum* late ellipticum, vix auriculatum, unguiculatum. *Alae* carina longiores.

Type: CAPE—3324 (Steytlerville): Baviaanskloof mountains, between Smitskraal and Wilgehof (-CB), 17/9/1973, *Oliver 4588* (STE, holotype; PRE, isotype).

Erect shrubs up to 2 m tall. *Stems* slender, glabrous, weakly ribbed, yellowish-brown. *Flowering shoots* clustered at the ends of the previous years shoots, densely appressed white pubescent between the angles, with elliptic pustules scattered along the upper edges. *Leaves* trifoliolate. *Stipules* 2,5–3,0 mm long, 0,5–0,8 mm wide, fused to the base of the petiole, shortly triangular, scarcely pubescent, densely encrusted with orange glands especially at the base. *Petioles* 1,5–2,0 mm long, gland-encrusted. *Leaflets* 15–25 mm long, 2,5–3,0 mm wide, flat, glabrescent, prominently nigro-punctate in dried specimens, narrowly obovate, somewhat falcate, base cuneate, apex recurved mucronate; laterals shorter and narrower than terminal leaflet. *Inflorescence* densely spicate, broadly-ovate becoming oblong, comprising from 20–30 sets of triplet flowers; each subtended by a single broadly ovate, pubescent glandular bract. *Flowers* 9–10 mm long, white; subsessile. *Peduncle* absent. *Calyx* 8 mm long; upper four teeth more or less equal, 6 mm long, 1 mm wide, keel tooth 8 mm long, 1 mm wide; vexillar teeth partially connate; lobes covered in small glands, densely black tomentose outside; tube 3,0–3,5 mm deep. *Standard* 9,0–9,5 mm long, 6,5 mm wide, broadly elliptic, emarginate, slightly auriculate, appendages absent; claw 2 mm long. *Wing petals* 9 mm long, 2,0–2,5 mm wide, longer than the keel, auriculate, claw 3,0–3,3 mm long; sculpturing upper basal, upper central and upper left distal comprised of 20–26 irregularly parallel lamellae. *Keel blades* 7 mm long, 2,5 mm wide, apex rounded; claw 3,5 mm long, purple blotch present on inner face of tip. *Androecium* 7 mm long; vexillar stamen 6,0–6,5 mm long, loosely fused to sheath for half its length. *Pistil* 6,5–7,0 mm long; ovary 2,5 mm long, pubescent; gynophore 0,5 mm long; style glabrous,0,4 mm thick at point of flexure; stigma papillose, forward-sloping. *Fruits* and seed unknown.

Otholobium pictum was first collected in 1930. Since then it has been collected only twice. But considering the inaccessibility of the terrain in which

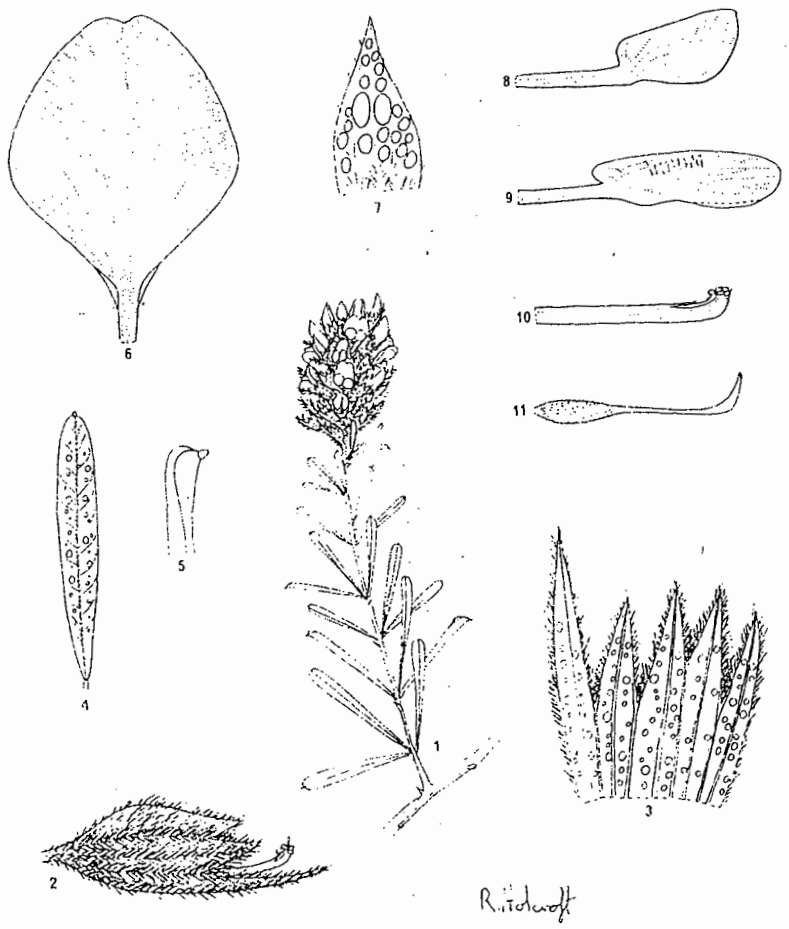

FIG. 2.
Otholobium pictum (Oliver 4588): 1. Flowering shoot; 2. Calyx with petals removed; 3. Calyx flattened out; 4. Leaf, surface view; 5. Tip of leaf; 6. Standard; 7. Stipule; 8. Keel; 9. Wing petal; 10. Androecium; 11. Pistil. (1, × ⅔; 4, × ca.1; 3, × 3; 6,8–11 × 4; 7, × 8)

this distinctive species occurs it is not surprising that the only collections made so far have been along the only two passable roads across the Baviaanskloof and Great Winterhoek Mountains. It is probably fairly common on the escarpment and with further collecting by mountaineers it should have its range broadened substantially. The discovery of this species stresses once again the poor state of collecting along the inland mountains east of Uitenhage and north of Stormsriver.

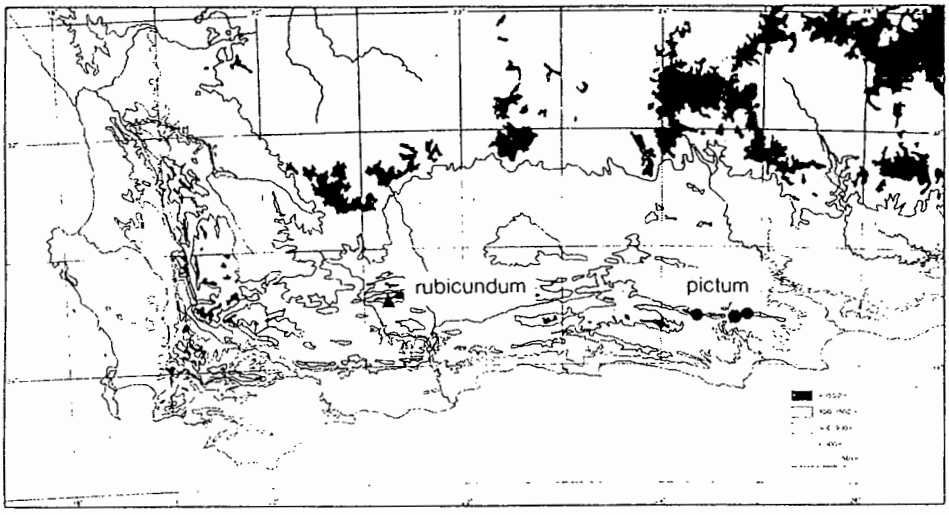

FIG. 3.
Known distribution of *Otholobium rubicundum* (▲) and *O. pictum* (●).

SPECIMENS EXAMINED

CAPE—3324 (Steytlerville): Baviaanskloof Mountains, between Smitskraal and Wilgehof (-CB), 17/9/1973, *Oliver 4588* (PRE, STE); Wintershoek Mountains (-DB), 15/9/1930, *Fries, Norlindh & Weirmarck 1065* (PRE, STE); Mountain road north of Patensie, 12/7/1954, *Taylor 1285* (PRE, SAAS).

DISTRIBUTION AND BIOLOGY

Otholobium pictum, a distinctive endemic of the Baviaanskloof Mountains, remains little known and seldom collected. It is quite surprising that such a distinctive shrub should have been without a name for so long.

This species flowers during August and September. Nothing more is known about its biology.

DIAGNOSTIC FEATURES

Erect 2 m tall shrub; leaflets flat, nigro-punctate; inflorescence 60–90-flowered, densely spicate; flowers white, each triplet subtended by a broadly ovate bract; standard broadly elliptic.

ACKNOWLEDGEMENTS

I would like to thank Mr. E. G. H. Oliver (Stellenbosch) for his comments about *O. pictum*; Miss C. M. Wilmot-Dear for the Latin diagnoses; Mrs. R. Holcroft for kindly drawing the plates and Dr. B. de Winter, Director, Botanical Research Institute, for permission to publish them. Finally I would like to thank the Curators of the Compton, Kew, Saasveld, Stellenbosch (Government) and National Herbaria for the loan of their material.

APPENDIX 10

Published paper No 8

Stirton, C.H. 1983b. Two new species of *Psoralea* (Fabaceae). *Jl. S. Afr. Bot.* 49: 329-335.

Jl S. Afr. Bot. 49 (4): 329–335 (1983)

TWO NEW SPECIES OF *PSORALEA* (FABACEAE) IN SOUTH AFRICA

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ABSTRACT

Two new species of *Psoralea* L. are described. One of these, *P. implexa* C.H. Stirton, is recorded from the Mountain Fynbos vegetation type on Du Toit's Peak, near Worcester; and the second, *P. trullata* C.H.Stirton, from the southern Cape Mountains.

UITTREKSEL

TWEE NUWE *PSORALEA* (FABACEAE) SOORTE IN SUID-AFRIKA

Twee nuwe *Psoralea*-soorte word beskryf. Die een, *P. implexa* C.H.Stirton is in Bergfynbos plantegroei op Du Toitspiek naby Worcester en die tweede, *P. trullata* C.H.Stirton, is op die suidelike Kaapse berge gevind.

Key words: *Psoralea*, sp. nov., Fabaceae, southern Cape, south western Cape.

INTRODUCTION

In 1930 Miss H. M. L. Forbes published her revision of 49 species of *Psoralea* L. in southern Africa. Since that time many new areas have been opened up to exploration and it is therefore not surprising that some new species have been discovered.

This paper is a tribute to Elsie Esterhuysen whose collections of Psoraleoid legumes in South Africa are of critical importance to our understanding of *Psoralea* and *Otholobium* C.H.Stirton. The two new species described here are rare and unusual representatives of the genus *Psoralea*.

Psoralea implexa C.H.Stirton, sp. nov.; *P. trullatae* C.H.Stirton affinis sed habitu graminoso, caulibus complanatis, floribus solitariis latericiis vel salmoneis, vexillolate elliptico et cupula brevite trifida differt.

Planta perennis rhizomata acervis implexos formans. *Caules* complanate, angulati glabrescentes. *Folia* unifoliolata. *Foliola* linearioblonga vel falcata, apice basique acuminatis. *Flores* solitarii axillares 12 mm longi laterici vel

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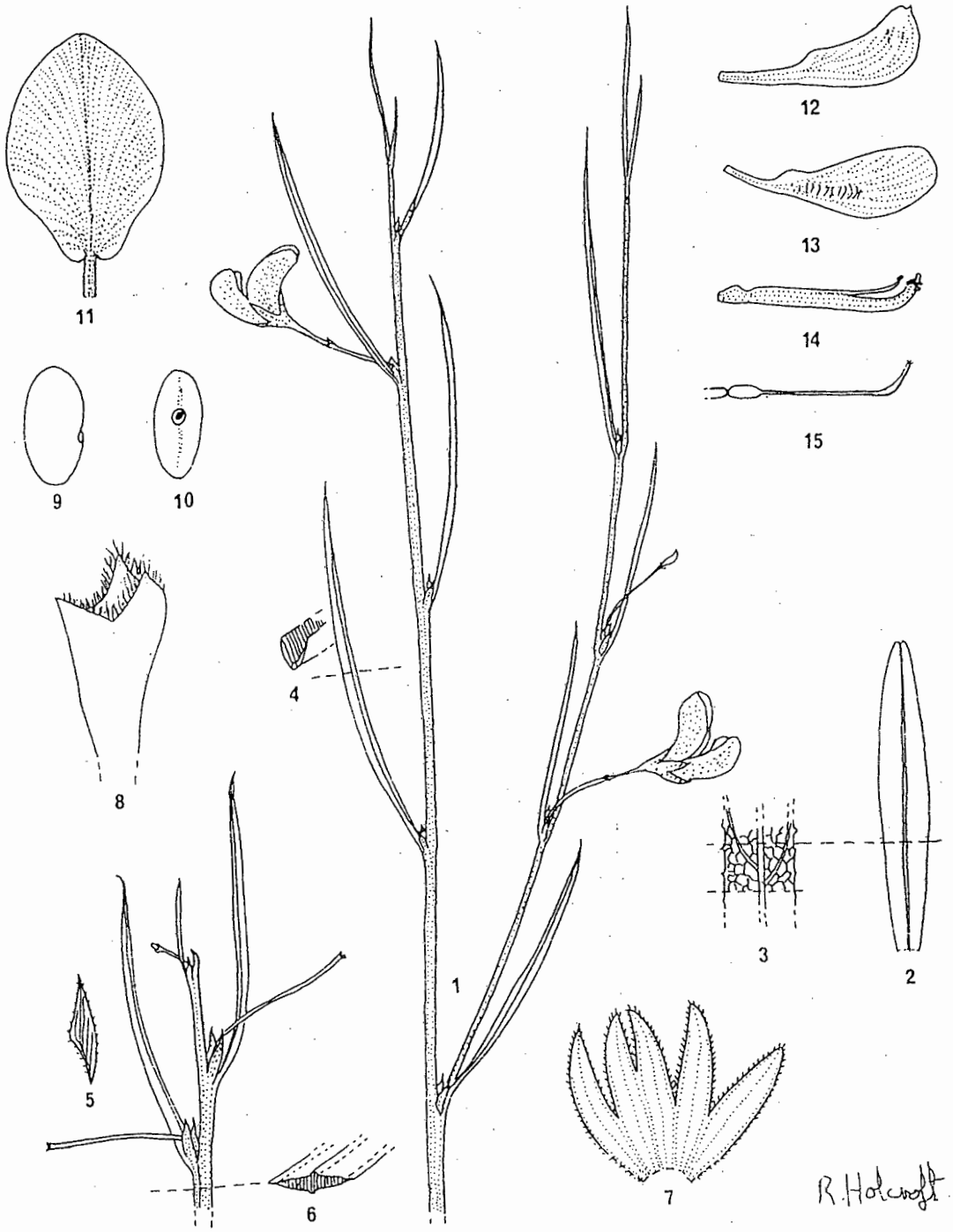
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R. Holcroft

salmonei. *Cupula* breviter trifida. *Calyx* accrescens. *Vexillum* late ellipticum. *Carina* alas superans apice rotundata.

Type: CAPE—3319 (Worcester): Delabat Ravine, NE ridge of Du Toit's Peak (-CA), 7/2/1975, *Esterhuysen 33765* (NBG, holotype; BOL, NBG, PRE, isotypes).

Rhizomatous multi-stemmed perennial growing in tangled heaps, with some trailing branches up to 1,7 m long. *Stems* flattened, angled, glabrescent. *Leaves* unifoliolate. *Stipules* 3–6 mm long, 1–3 mm wide, fused at base, adnate to base of petiole, falcate; blade glabrous, glandular, margins papillose or hairy. *Petioles* 1 mm long, glabrous. *Leaflets* 35–60 mm long, 2–3 mm wide, linear-oblong to falcate, basal leaves shorter and up to 4 mm wide; glabrous, glandular; apex acuminate, base acuminate. *Inflorescence* reduced to a single flower, axillary, forming near the ends of lateral branches. *Flowers* 12 mm long, brick-red to salmon. *Cupulum* shortly trifid. *Calyx* 8 mm long; teeth equal, 8 mm long, 1,8–2,0 mm wide; vexillar lobes fused for three-quarters their length, incurving; tube 3 mm deep; lobes glabrous outside, finely ciliate on margins of the teeth and on inner face of teeth; accressent in fruit. *Standard* 12 mm long, 8 mm wide, broadly elliptic, weakly auriculate, appendages absent; glabrous; apex convex, slightly beaked; claw 3 mm long. *Wing petals* 10 mm long, 3 mm wide at widest point, 1,5 mm wide below weak auricle; claw 3,5–4,0 mm long; sculpturing upper basal comprised of 8–12 irregular, reclined lamellae. *Keel blades* 9,0–9,5 mm long, 3,5 mm wide, rounded at apex and beaked below, shorter than the wing petals; claw 4 mm long. *Androecium* 9 mm long, 2 mm wide at base, split; vexillar stamen lightly fused for the middle part of its length. *Pistil* 9 mm long; ovary 1,5 mm long, glabrous except for a few glandular hairs on the sides; gynophore present, 1 mm long; height of curvature 2,5 mm; style glabrous, somewhat thickened before the point of flexure; stigma capitate, finely penicillate. *Fruit* 6 mm long, 4 mm wide, papery, reticulate. *Seed* brown black, 5 mm long, 3 mm wide (**Fig. 1**).

This species is so distinctive that I have no hesitation in describing it as new.

SPECIMENS EXAMINED

Type only, as above

FIG. 1.

Psoralea implexa (Esterhuysen 33765): 1. Flowering branch; 2. Leaflet; 3. Undersurface of leaflet; 4. Transverse section of leaflet; 5. Stipules; 6. Transverse section of stem; 7. Calyx; 8. Cupulum; 9. Lateral view of seed; 10. Hilar view of seed; 11. Standard; 12. Keel blade; 13. Wing petal. 14. Androecium. 15. Pistil. (1, 4, × 1; 2, × 2; 2, 3, 7, 9–15, × 3; 5, 6, × 5; 8, × 8)

DISTRIBUTION AND BIOLOGY

Psoralea implexa is a rare mountain endemic collected for the first and only time just six years ago (Fig. 2). It was found growing by Miss Elsie Esterhuysen at 650 m on steep open rocky stony slopes of kloofs with western and eastern aspects. Flowering takes place in early February. Nothing is known about its biology.

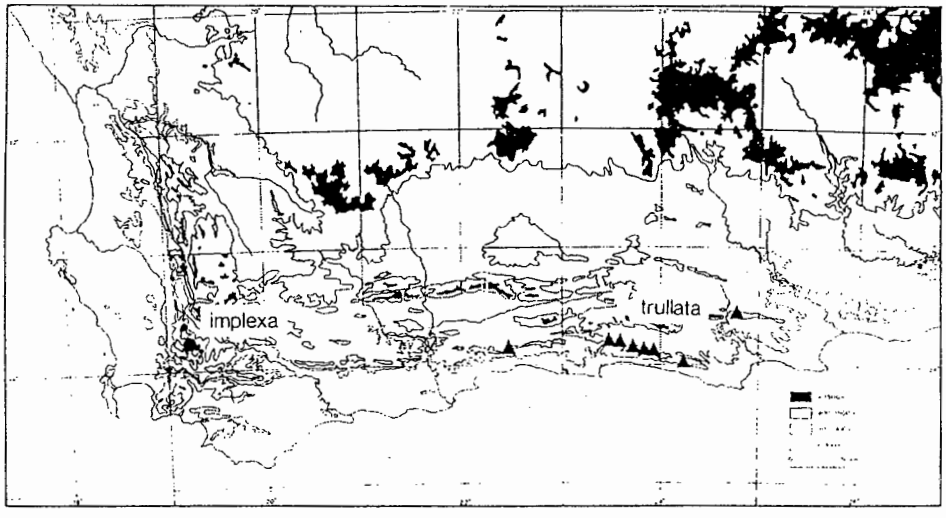


FIG. 2.
Known distribution of *Psoralea implexa* (●) and *P. trullata* (▲) in South Africa.

DIAGNOSTIC FEATURES

Grass-like habit, flattened stems, solitary brick-red to salmon-coloured flowers, broadly elliptic standard and shortly trifid cupulum.

Psoralea trullata C.H.Stirton, sp. nov.; *P. restioides* Eckl. & Zeyhr. et *P. implexae* C.H.Stirton atque *P. glaucinae* Harv. affinis sed vexillo trulliforme, cupulae dentibus longioribus angustioribus, carina dentibusque calycis alabastro valde attenuatis.

Suffrutex implexa multicaulis usque 300 mm alta. *Caules* usque 2 mm longi glabri manifeste glandulosi. *Folia* trifoliolata inferiores unifoliolata basales plani latique superne gradatim trifoliolata conduplicata angustioribus, foliola linearia vel linearioblonga basi cuneata apice acuminata. *Flores* solitarii axillares 10–12 mm longi purpureo-coeruli. *Cupula* 3–5 mm longa, tubo 1,5 mm longo, trifida, duobus dentibus interioribus 4,0–4,5 mm longis anguste triangularibus, dente exteriori rotundato quam interiores 4–5-plo bre-

viori. *Calyx* accrescens. *Vexillum* latissime triangulare vel trullatum. *Carina* manifeste attenuata alas prominente auriculatas valde superans.

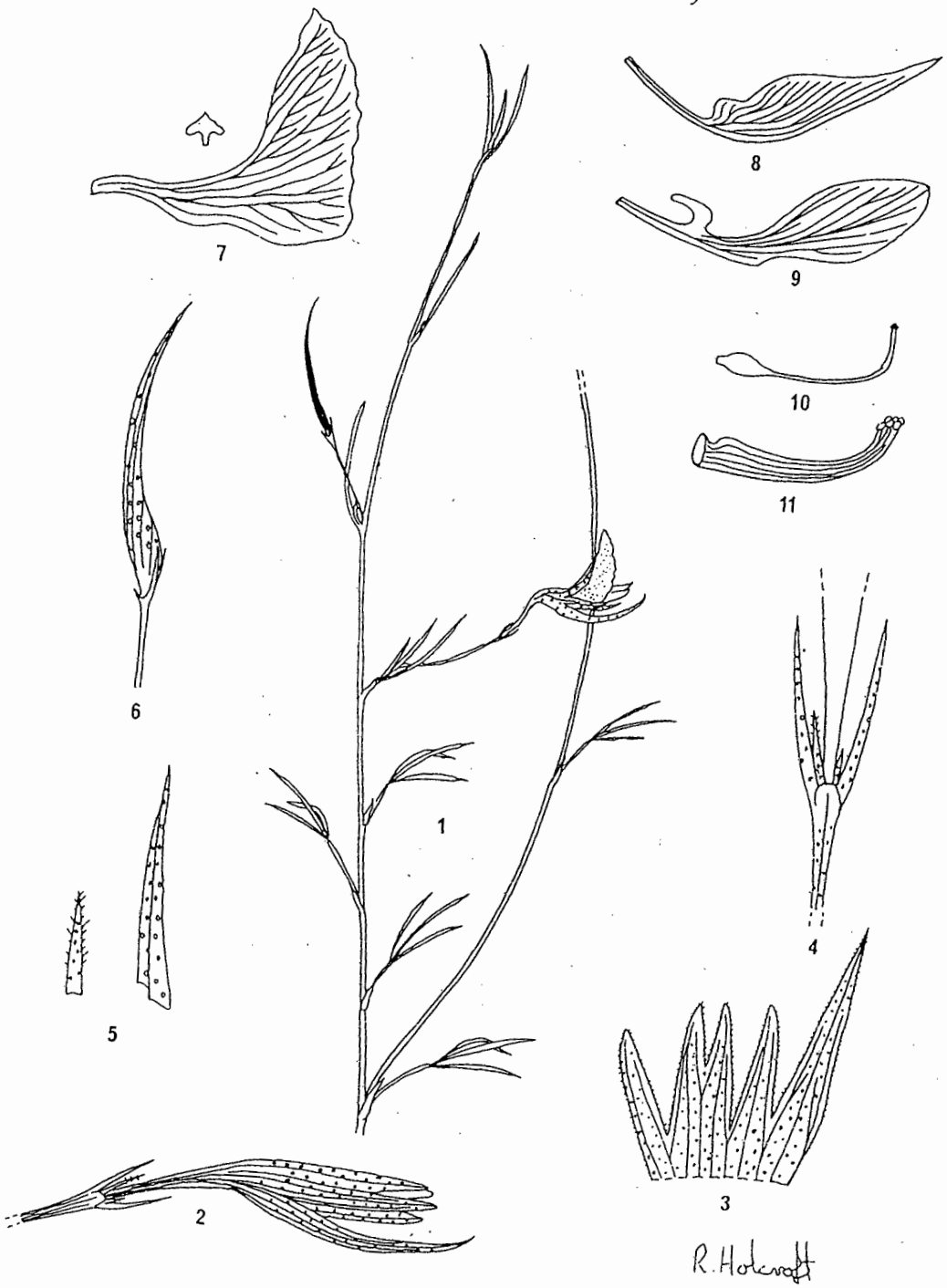
Type: CAPE—without precise locality: Blaauboschbaai, *Fourcade 2827* (PRE, holotype; STE, isotype).

Tangled multi-stemmed suffrutex, up to 300 mm tall. *Stems* as much as 2 m long, glabrous, ribbed, prominently glandular. *Leaves* trifoliolate, occasionally unifoliolate below. *Stipules* 5–7(10) mm long, adnate to the petiole, tightly clasping the stem, fused for three-quarters their length; teeth narrowly triangular, 2,0–4,5 mm long. *Petioles* 5–12 mm long. *Leaflets* 10–16 mm long, 0,5–2,0 mm wide; basal leaves flat and broader becoming conduplicate and narrower towards the apical regions; glabrous, linear to linear-oblong; base cuneate, apex acuminate; laterals equal to or somewhat shorter than the terminal leaflet. *Inflorescence* reduced to a single flower, axillary, occurring in the last 2–5 axils. *Flowers* 10–12 mm long, purplish-blue, subtended by two unequal bracts 2–3 mm long; pedicel 2–5 mm long. *Peduncle* 10–25 mm long; cupulum 3–5 mm long with 1,5 mm deep tube, trifid, inner pair of teeth 4,0–4,5 mm long, narrowly triangular, outer tooth rounded, 4–5 times shorter than the inner pair, 1,0–1,5 mm long. *Calyx* 12 mm long; upper four teeth equal, 8 mm long, keel tooth broader and 4 mm long, upcurving, vexillar lobes fused for two-thirds their length; tube 2,5–3,0 mm deep, ribbed; lobes glabrous inside and outside, ciliate along margins of the teeth, densely glandular, accressent in fruit. *Standard* 13–14 mm long, 8 mm wide, very broadly triangular to trullate; claw 2,5 mm long; scarcely auriculate, appendages obscure, may be absent. *Wing petals* 14–15 mm long, 3 mm wide, claw 3 mm long; prominently auricled, thumb-like, 1,5 mm long. *Keel blades* 20–21 mm long, slender, narrowly beaked, exceeding the wing petals; claw 4 mm long. *Androecium* 6 mm long, vexillar stamen free. *Pistil* 6 mm long; ovary 2 mm long; gynophore present, 0,5 m long; height of curvature 1,5–1,6 mm long; style glabrous, thickened at point of flexure; stigma capitate, penicillate. *Fruit* 5–6 mm long, 3 mm wide, black, paper-thin, broadly reticulate. *Seeds* 4 mm long, 2,5 mm wide, blackish-brown (Fig 3).

In the past this species has been referred to either *P. glaucina* Harv. or to *P. restioides* Eckl. & Zeyhr. It is easily separated from those species however by its prominent elongated buds, the trullate standard, and very distinctive keel.

SPECIMENS EXAMINED

CAPE—3322 (Oudtshoorn): Tolberg, top of Outeniqua Pass (-CD), 8/12/1962, *H. C. Taylor 4469* (STE).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R. Holcroft

—3323 (Willowmore): de Hoek farm, Langkloofberge, 22/2/1945, *Fourcade 6535* (BOL); Helpmekaar Peak (-DC), 28/1/1941, *Esterhuysen 4604* (BOL); Formosa Peak, Tsitsikamma Mountains, 30/1/1941, *Esterhuysen 4651* (BOL); Cradock Peak, Montagu Pass, 1/1940, *Stokoe s.n.* (SAM *54873*); Camel Pile, Tsitsikamma Mountains (-CD), 12/1/1947, *Esterhuysen 13573* (BOL); Tsitsikamma Mountains near Joubertina, 26/1/1950, *Esterhuysen 16764* (BOL, PRE).
—3324 (Steytlerville): Witte Els Bosch Peak (-CD), 16/11/1941, *Esterhuysen 6789* (BOL); Cockscomb Peak, Great Winterhoek Mountains (-DB), 3/3/1957, *Esterhuysen 27144* (BOL).
Without precise locality: Blaauboschbaai, *Fourcade 2827* (PRE, STE).

Distribution and Biology

Psoralea trullata is endemic to the southern Cape and is found growing on the Tsitsikamma, Langkloof, Outeniqua and Great Winterhoek Mountains (Fig. 2), between the altitudes of 1 100 and 1 600 m. Very little is known about the habitat preferred by this species except that it is associated with steep rocky slopes and ledges *(Esterhuysen 27144),* apparently on peaty soils overlying TMS rock *(Taylor 4469).* Flowering takes place between November and February.

Diagnostic Features

Tangled herb; trullate standard; elongated flower bud; trifid unequally toothed cupulum; narrowly attenuated keel-blade exceeding the prominently auricled wing petals; accrescent calyx.

Acknowledgements

The author wishes to acknowledge the assistance and facilities made available to him at the Botanical Research Institute, Pretoria and Stellenbosch, the Compton Herbarium and the Bolus Herbarium. The illustrations were drawn by Mrs. Rosemary Holcroft of the Botanical Research Institute, Pretoria and are gratefully acknowledged. Miss C. M. Wilmot-Dear kindly provided the Latin diagnoses.

References

Forbes, H. M. L., 1930. The genus *Psoralea* Linn. *Bothalia* 3: 116–136.

Fig. 3.
Psoralea trullata (Fourcade 2827): 1. Flowering branch; 2. Calyx in fruit; 3. Calyx; 4. Cupulum; 5. Bracts subtending each flower in a cupulum; 6. Bud; 7. Standard; 8. Keel blade; 9. Wing petal; 10. Pistil; 11. Androecium. (1, × 1; 2, 3, 6, × 3; 7–11, × 4; 4, × 5; 5, × 8).

APPENDIX 11

Published paper No 9

Stirton, C.H. 1984. Name changes in *Psoralea* (Fabaceae). *Jl. S. Afr. Bot.* 50,4: 461-462.

Jl S. Afr. Bot. 50 (4): 461–462 (1984)

NAME CHANGES IN *PSORALEA* (FABACEAE)

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ABSTRACT

1. The new combination *Psoralea monophylla* (L.) C. H. Stirton is made, based on *Glycine monophyllum* L. 2. The new name *Psoralea plauta* C. H. Stirton is designated for *Hallia flaccida* Thunb. (1799), non *P. flaccida* Näbelék (1923). 3. The new name *P. cataracta* C. H. Stirton is designated for *H. filiformis* Harv. (1836), non *P. filiformis* Poir. (1804).

UITTREKSEL

NAAMSVERANDERING IN *PSORALEA* L. (FABACEAE)

1. 'n Nuwe kombinasie *Psoralea monophylla* (L.) C. H. Stirton word gemaak, gebasseer op *Glycine monophyllum* L. 2. Die nuwe naam *Psoralea plauta* C. H. Stirton word gegee aan *Hallia flaccida* Thunb. (1799), non *P. flaccida* Näbelék (1923). 3. Die nuwe naam *P. cataracta* C. H. Stirton word aan *H. filiformis Harv. (1836)*, non *P. filiformis* Poir. (1804) gegee.

Key words: *Psoralea*, Fabaceae.

1. **Psoralea monophylla** (L.) C.H.Stirton, comb. nov.

Glycine monophyllum L., Syst. nat. ed. 12, 2: 484 (1767); Mant. pl. 101 (1767); Mant. pl. Alt. Addim. 516 (1771); non Burm. 1768; auct. non L.: Jacq., Pl. Hort. Schoenbr. 2: 57, t. 257 (1797). Lectotype: "C.B.S." (LINN, specimen 901. 20, !).

Hedysarum cordatum Thunb. in Nov. Act. Reg. Soc. Sci. Upps. 6: 41 (1799); non Jacq. (1800). Lectotype: "Crescit in campis graminosis ultra Swellendam, C.B.S." (UPS, specimen *17161*). Nomenclaturally superfluous name. *Hallia cordatum* (Thunb.., Schrad. Journ. 1: 321 (1799); Gen. nov. Pl. 11: 158 (1800); Prodr. 131 (1800); W. T. Aiton, Hortus Kew. 4: 338 (1812); Thunb., Fl. Cap. 593 (1823); DC., Prodr. 2: 123 (1825); Eckl. & Zeyh., Enum. 172 (1836); E. Mey., Comm. 82 (1836). *Psoralea cordata* (L.)

*B. A. Krukoff Botanist

Accepted for publication 25th May, 1984.

Salter in Jl S. Afr. Bot. **5**: 46 (1939); Salter in Adamson & Salter, Fl. Cape Penins. 490 (1950).

Salter transferred this species from *Hallia* to *Psoralea* but the basionym *Hedysarum cordatum* L. does not exist.

Hedysarum saggitatum Poir., Encyl. **6**: 403 (1804). Type: not seen.

Hallia saggitata (Poir.) Desv., Ann. Sci. Sér. **9**: 408 (1826). *Desmodium saggitatum* (Poir.) DC., Prodr. **2**: 326 (1825).

2. **Psoralea plauta** C.H.Stirton, nom. nov.

Hallia flaccida Thunb. in Schrad. Journ. 319 (1799); Prodr. 131 (1800); W. T. Aiton, Hortus Kew. **4**: 338 (1812); Thunb. Fl. Cap. 593 (1823); DC., Prod. **2**: 123 (1825); Eckl. & Zeyh., Enum. 172 (1836). Lectotype: South Africa, "e Cap. Bon. Spei." *Thunberg s.n.* (UPS, specimen *17162*), non Năbelék (1923).

3. **Psoralea cataracta** C.H.Stirton, nom. nov.

Hallia filiformis Harv. in Harv. & Sond. Fl. Cap. **2**: 232 (1836). Type: South Africa, Tulbagh Waterfall, *Pappe s.n.* (TCD, holotype!), non Poir. (1804).

ACKNOWLEDGEMENTS

I wish to express my appreciation to Dr. C. Jarvis of the British Museum (Natural History), and to Drs. B. Verdcourt and R. K. Brummitt (Royal Botanic Gardens, Kew) for their unstinted advice on the nomenclature of *Psoralea monophylla*. I would also like to thank the Curators of TCD and LINN for allowing me access to their valuable collections.

APPENDIX 12

Published paper No 10

Stirton, C.H. 1985b. Book review of V.H. Heywood & D.M. Moore, *Current concepts in Plant Taxonomy*, *Annals. Bot.* 56: 277-279.

Annals of Botany 56, 277–279, 1985

Book Review

HEYWOOD, V. H. and MOORE, D. M. (Editors). *Current Concepts in Plant Taxonomy.* Proceedings of an International Conference held in Reading, 1982. xv+432 pp. 1984. Academic Press. £35 (Hardback).

This is a subtle, overly-confident book. Readers who attended the actual conference will marvel at how the editors have camouflaged the exciting doctrinal clashes that took place. In its place they offer a useful but pedestrian skim that will inform rather than emancipate. This is not a book for those who seek guidance on the current paradigms of taxonomy. Nonetheless, it will be a useful work for many biologists as long as they are aware that the various authors who contributed belong to competing schools of thought.

The trendy title attracts immediately. It is certain to capture the attention of armchair book-orderers, but does it deliver? Frankly the title is a misnomer. It just does not fit a feeling of current general notions or ideas. A more apt title would have been *Recent Advances*.

The book is divided into eight sections: Introduction; Institutional Resources; Recent Approaches in Morphology and Anatomy; Karyology and Genetics; Ecology and Genetics; Chemistry, Taxonomy and Systematics; Data Processing and Taxonomy; and finally Taxonomic Priorities.

Two themes dominate the book. The first theme, adopted by most authors, concentrates on the prior 15 years research but offers little commentary about the various competing concepts that gave rise to the work surveyed. The second theme is less reflective and questions the aims and concepts of the same period yet provides clear indications of current and future trends. The contrast, for example, between Cullen's provocative paper 'Libraries and Herbaria' and Heywood's 'The Current Scene in Plant Taxonomy' is startling. The former calls for a radical rethink about matters far beyond libraries and herbaria; in effect that all is not well with taxonomy. The latter while concluding that 'the absence of any major new development in plant systematics and taxonomy in the past few years. . . has given taxonomy such a breathing space' misses Cullen's obvious point that there is no point in reordering priorities if outmoded practices are used to implement them. It is the second theme that attracts.

The chapters on 'Libraries and Herbaria', 'Botanic Gardens and Experimental Grounds' and 'Completing the Inventory' will be of most interest to a broader audience and should be read by all taxonomists. Do not be put off by the titles. The articles are an easy read but more importantly they raise serious questions about the aims and health of the taxonomic community. Some of the recommendations should be taken up by the users of taxonomic products.

There is an urgent need for biologists to participate in what some leading taxonomists are calling 'a period of sober and mature reflection' in taxonomy. Users of taxonomic products must state clearly what they need and not allow the taxonomic community to turn in on itself. As Cullen states 'The introversion built up leads inevitably to ritualization, and a mystery cult develops, with its arcana, its sacred texts and rules of procedures, its priesthood and prophets, its orthodoxy and schisms. Like any cult, its sacred texts are not for the uninitiated, so they are written in specialist language under the restriction of evil-eye averting formalities. Again like any cult, there are controversies about how many angels can sit on a pin, sectarianism and ancestorworship.' The current furore among 'inflorescence-classifiers' is a good example as is the debate surrounding flora-writing. Are you a happy user?

The chapters on 'The Taxonomic Importance of the Leaf Surface' (Stace), 'Microstructural Features of Seed Surfaces' (Barthlott) and 'Systematic Anatomy and Embryology' (Cutler) provide useful updates and introduction to the literature. It is satisfying to see that standards have been set for the description of leaves and venation systems and that some concordance exists about stomatal types. Less rewarding is the state of hair and vestiture terminology. One emerging area of study is the biology and ecophenetic variability of plant microstructures. The preliminary results are very promising for taxonomists and have great importance for applied biologists. Barthlott's conclusion, for example, might surprise some. He feels confident that differences in seed-coat characters appear to reflect genetic–phylogenetic differences in the plants concerned and that the evidence it provides is just as good as palynological data. Certainly given the greater complexity of seed structure over pollen grains it does not seem unlikely.

Taximetrics, or numerical taxonomy as it used to be called, has become quite subdued over the last 15 years. Gone are the wild claims of its earlier supporters. This volume scarcely covers what was once heralded as the panacea for classification. It has been ousted by cladistics (phylogenetic systematics). Cladistics was a late starter in botany. Whether it will attract botanists in the way it has dominated zoology remains to be seen. There is little doubt though that it is bringing a new excitement into 'plant taxonomy'. Cladistics is claimed to be an empirical method which defines monophyletic groups based on internested sets of uniquely derived characters. The method is basically rather simple once one has waded through the indigestible jargon and has found the most appropriate of many algorithms with which to analyze one's data. The real emergence of cladistics will occur when better algorithms become available to deal with large sets of data of the size used by most taxonomists. The convergence of taximetrics and cladistics has been fun to watch. Numerical cladistics is now well-established and, linked with the increasing power and availability of microcomputers, could become even more fashionable.

Chemistry and karyology have become standard topics for most conferences and this one is no exception. It is refreshing therefore to see that these fields have changed in emphasis over the period reviewed. Chemical and karyological data have became more useful now that chemists and karyologists are conceding that variation, parallelism and convergence present problems similar to those found in plant systematics and population biology. All very well but a bit pointless if editors of phytochemical journals continue to accept articles based on unvouchered materials. What use is an empirical method if it cannot be repeated or its results used because the source material is unverifiable? This aside, there are some useful points made by Harborne (Chemical Data in Practical Taxonomy), Kubitzki (Phytochemistry in Plant Systematics and Evolution) and Grielhuber (Chromosomal Evidence in Taxonomy). Grielhuber's excellent summary combines cladistic methods of analysis with new types of chromosomal evidence in what he calls appropriately the 'New Karyosystematics'. Valuable reading for anyone interested in chromosomes.

The chapter on 'Taxonomy and Geography' (Moore) is a minefield for the uninitiated. Biogeography is perhaps one of the most controversial and fastest growing areas of biology. This is not a balanced introduction to the field and should be read with caution. The author has some astute observations but spoils them with a biased interpretation of the literature. The cavalier dismissal of Croizat will not please the panbiogeographers, and though it may please cladistic biogeographers they too will feel misrepresented. All this of course indicates a great flux and hence an emerging bandwagon. Biogeography will come of age in the next decade and will have a huge impact on applied biology. Something to look out for.

Another area of study undergoing renewal is that of infraspecific classification. Snaydon ('Infraspecific Variation and its Taxonomic Implications') provides a useful

assessment and suggests future lines of research. This paper and Kay's revealing paper on 'Variation, Polymorphism and Gene-flow within Species', taken together, should show classical taxonomists that biosystematics and genecology have matured considerably and have much to offer. The separation of the adaptive and non-adaptive components of structure and function, for example in pollen, is one aspect. See Blackmore's paper on 'Pollen Features and Plant Systematics'. Interested readers should also consult *Plant Biosystematics* (Grant, 1984). This book, covering much of the same ground as *Current Concepts*, but in a far more stimulating and broader way, is an essential companion. It is quite illuminating to read the same topic in each book and for some topics essential to do so if one wants to find out what is going on.

Finally, a few quibbles. Firstly, it is a bit distressing that many of the authors cite too much of their own unpublished work and draw too heavily on their own publications. Secondly, given that this book will probably be used by students it would have been helpful to have had a short glossary for unusual words, e.g. breviaxy and successiformy. Thirdly, a plea. Is not the word *gaps* simpler than *lacunae*? Why not return to 'gaps in our knowledge'? And finally is there really any difference between taxonomy, systematics, cladistics, biosystematics, and phenetics? If you end up thinking so blame the editors. Each contributor seems to follow a different definition.

Current Concepts in Plant Taxonomy is a difficult book to judge. It depends on how seriously one takes the title as criterion. Events have overtaken some of the chapters to their detriment and one questions whether such books should take so long to publish. *Plant Biosystematics*, also a conference volume, came out within a year and is the richer for it. Both should be read by taxonomists. As to a wider audience? Yes, both have much to recommend them if not for key individual chapters then at least for the breadth of their coverage.

C. Stirton

REFERENCE

GRANT, W. F. (Editor), 1984. *Plant Biosystematics*. Proceedings of the Symposium of the International Organization of Plant Biosystematists held in Montreal, 17–21 July 1983. 674 pp. Academic Press, London.

APPENDIX 13

Published paper No 11

Boardley, M., Stirton, C.H. and Harborne, J.B. 1986. A chemosystematic survey of the tribe Psoraleeae. *Biochem. Syst. & Evol.* 14,6: 603-613.

Biochemical Systematics and Ecology, Vol. 14, No. 6, pp. 603–613, 1986.
Printed in Great Britain.

0305-1978/86 $3.00+0.00

A Chemotaxonomic Survey of the Tribe Psoraleeae in Africa

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Key Word Index—*Psoralea*; *Cullen*; *Otholobium*; *Bituminaria*; *Orbexilum*; Leguminosae; flavones; flavone *C*-glycosides; furanocoumarins; essential oils; isoflavones; biochemical systematics.

Abstract—A study of the leaf flavonoids, furanocoumarins and essential oils of 51 species (three genera) of the tribe Psoraleeae (Fabaceae) has provided chemical data to support the recent subdivision of the large worldwide genus *Psoralea* into a number of segregate genera. The flavonoid patterns in most species were very similar, consisting largely of proanthocyanidins and complex mixtures of flavone *O*- and *C*-glucosides. *Psoralea repens*, the only maritime species to be examined, is unique in containing only rutin. Three isoflavones (daidzein, formononetin and genistein) were of widespread occurrence. The genera *Psoralea* and *Otholobium*, which could not be separated on flavonoid data, were clearly demarcated by their essential oils. Furanocoumarin patterns were useful for the characterization of species.

Introduction

The Papilionoid legume tribe Psoraleeae was thought in 1981 to comprise six genera: *Psoralea, Cullen, Otholobium, Bituminarea, Hallia* and *Orbexilum* [1]. Prior to that, most modern authors recognized either a single genus *Psoralea* in the tribe Psoraleeae (Benth.) Rydb. or a number of genera in the broader-based tribe Psoralieae Hutch. These opinions however were not based on any comparative world-wide study but rested entirely on the nineteenth century classifications of Bentham [2], De Candolle [3], Meyer [4] and Ecklon and Zeyher [5].

Recent studies by one of us (C.H.S.) would indicate that the genus *Hallia* is better placed as a sub-genus of *Psoralea* and it is also apparent that the American genus *Orbexilum* should be sub-divided into a number of genera (Grimes, J., personal communication). It is evident therefore that generic limits in the tribe are still uncertain, and although the Old World genera have been studied in considerable detail their relationship to the lesser known New World genera is still unresolved. It is the purpose of this paper to show that chemical evidence can provide useful insights into the taxonomy and phylogeny of the group.

(*Received* 6 *June* 1985)

The only detailed chemical study made so far of the tribe Psoraleeae has been that of Ockenden *et al.* [6] who surveyed the flavonoid chemistry of 30 species of North American representatives of the genus *Psoralea* sensu lato (*Orbexilum*). This work revealed the presence of a complicated pattern of *C*-glycosylflavones such as orientin, isoorientin, lucenin and vicenin, as well as *O*-glycosides of luteolin, apigenin and chrysoeriol. Their results indicated that flavonoids provided useful markers for a number of species. No attempt however was made by the authors to superimpose their data on Rydberg's [7] generic fragmentation of *Orbexilum*.

The present work on African species of the tribe has revealed a very similar flavonoid pattern to that of the North American species. The study was extended however to cover a broader range of compounds including isoflavones, proanthocyanidins, essential oils and furanocoumarins. In this way it was hoped to test whether different chemical compounds, from the same organ, would provide the same or different levels of taxonomic information. The decision to include essential oils devolves

on the characteristic presence of unique leaf gland types in the genus (Turner, G., personal communication). No such chemical studies have been reported before. Furanocoumarins were studied as they were known to occur only in the tribe Psoraleeae [8]. Psoralen has been isolated from the seed coat of *Psoralea subacaulis* as a germination inhibitor [9, 10], and of *P. psoraleoides* [11]. Furanocoumarins have also been suggested in the literature to be powerful phototoxins [12].

Results

Flavonoids

A composite representation of the flavonoids (and tentative identifications) of 51 species of genera *Psoralea* and *Otholobium* analysed is shown in Fig. 1. The flavone *O*-glycosides and flavone *C*-glycosides detected on two-dimensional chromatograms are shown in Tables 1 and 2.

The genus *Cullen*, represented by *C. obtusifolia*, has no flavonoids in common with the genera *Psoralea* and *Otholobium*.

One species stands out from all the rest. *Psoralea repens* does not exhibit the characteristic pattern of flavone *O*- and *C*-glycosides typical of all the other species examined but does contain high concentrations of rutin (quercetin 3-rutinoside). This species is the only creeping dune plant of the tribe and is distributed along sandy stretches of the southern Cape coastline. The striking absence of common psoraleoid flavonoids in this genus necessitated that more samples were analysed. To this end three extra collections were obtained and analysed. The four collections sampled were therefore representative of the entire range of distribution. All the populations were found to contain rutin only. Flavonols such as quercetin were absent from the leaves of all the other species studied, including a number of American species.

The commonest flavonoids found, present in over 80% of species, were orientin, vicenin, isoorientin *O*-glycoside, compound 4, various di-*C*-glycosides of luteolin and chrysoeriol (Fig. 1, Table 2). Less common flavonoids were apigenin *O*-glycoside (25% species), isovitexin (26% species) and unidentified compound 9 (49% species). The unidentified compound 12 was found in the species *P. nodosa*, *O. caffra* and *O. wilmsii* where it replaced isoorientin. These three species are the commonest and most widespread species of the eastern summer rainfall region of southern Africa. Although this flavonoid does not occur in the isolated *O. gazense*, also from eastern parts, there is the suggestion that this compound has a geographical distribution.

TABLE 1. LEAF FLAVONOIDS PRESENT IN *PSORALEA, OTHOLOBIUM* AND *CULLEN*

Voucher No.	Spp.	1	2	3	4	5	6	7	8	9	10	11	12*
8746	*P. aculeata*	+	+	+	+	+	+	+	–	+	+	–	–
9605	*P. affinis*	+	–	+	+	+	+	+	–	–	+	–	–
9623	*P. affinis*	+	+	+	+	+	+	+	–	–	+	–	–
9718	*P. affinis*	+	–	+	+	?	?	+	?	+	+	–	–
8250	*P. arborea*	+	+	+	+	+	+	+	+	–	+	–	–
9740	*P. arborea*	+	–	+	+	+	+	+	+	+	+	–	–
9736 }	*P. arborea* ×	+	–	+	+	?	?	+	–	+	+	–	–
9737 }	*P. effusa*	–	–	+	+	+	+	+	–	–	+	–	–
8420	*P. asarina*	+	–	+	+	+	+	+	+	–	–	.	–
8256	*P. axillaris*	+	+	+	+	+	+	+	–	+	+	–	–
9163	*P. connixa*	+	–	+	+	+	+	+	?	+	+	–	–
9183	*P. connixa*	+	–	+	+	+	+	+	?	+	+	–	–
9526	*P. connixa*	+	?	+	+	+	+	+	?	–	+	–	–
8220	*P. effusa*	+	+	+	+	+	+	+	–	+	+	–	–
9102	*P. effusa*	+	–	+	+	?	?	+	+	–	+	–	–
9478	*P. effusa*	+	–	+	+	+	+	+	–	+	+	–	–
9712	*P. effusa*	+	–	+	+	+	+	+	+	+	+	–	–
9739	*P. effusa*	+	–	+	+	?	?	+	–	+	+	–	–
9509	*P. exile*	+	–	+	+	+	+	+	–	+	+	–	–

TABLE 1—*CONTINUED*

Voucher No.	Spp.	1	2	3	4	5	6	7	8	9	10	11	12*
9521	*P. exile*	+	−	+	+	+	+	+	−	+	+	−	−
9602	*P. glabra*	+	−	+	+	+	+	+	−	+	+	−	−
8333	*P. imbricata*	+	−	+	−	−	−	+	+	−	−	+	−
8211	*P. laxa*	+	+	+	+	+	+	+	+	+	+	−	+
8093	*P. nodosa*	+	−	+	+	+	+	−	−	+	+	−	+
8258	*P. odoratissima*	+	−	+	+	+	+	+	+	−	+	−	−
8219	*P. oligophylla*	+	+	+	+	+	+	+	−	+	+	−	−
9184	*P. oreopolum*	+	−	+	+	+	+	+	−	−	+	−	−
9185	*P. oreopolum* × *P. ramulosa*	+	−	+	+	+	+	+	−	−	+	−	−
9186		+	−	+	+	+	+	+	+	+	+	−	−
9187		+	−	+	+	+	+	+	−	+	+	−	−
9562	*P. papillosa*	+	−	+	+	+	−	+	?	+	+	−	−
8479	*P. pinnata*	+	−	+	+	+	+	+	−	+	+	−	−
9757	*P. pinnata*	+	+	+	+	+	+	+	−	−	+	−	−
8297	*P.* sp. cf *pinnata*	+	−	+	−	+	+	+	−	−	+	−	−
9292	*P.* sp. cf *pinnata*	+	−	+	+	+	+	+	−	−	+	−	−
9742	*P.* sp. cf *pinnata*	−	−	+	+	+	?	+	−	−	+	−	−
8451	*P. pullata*	+	−	+	+	+	+	+	−	+	+	−	−
9142	*P. ramulosa*	+	−	+	+	+	+	+	?	+	+	−	−
—	*P. repens*	−	−	−	−	−	−	−	−	−	−	+	−
8413	*P. repens*	−	−	−	−	−	−	−	−	−	−	+	−
9441	*P. repens*	−	−	−	−	−	−	−	−	−	−	+	−
9681	*P. speciosa*	+	−	+	+	+	+	+	−	+	+	−	−
9709	*P. speciosa*	+	−	+	+	+	+	+	+	−	+	−	−
105	*P. tenuifolia*	+	+	+	+	+	+	+	−	−	+	−	−
9506	*P. tenuifolia*	+	?	+	+	+	+	+	−	?	+	−	−
9715	*P. tenuifolia*	+	−	+	+	+	+	+	−	+	+	−	−
9367	*P. verrucosa*	+	−	+	+	?	?	+	−	?	+	−	−
9627	*P.* sp.	+	−	+	+	+	−	+	+	+	+	−	−
9708	*P.* sp.	+	−	+	+	+	?	+	+	+	?	−	−
8445	*O. bolusii*	−	−	+	−	+	+	+	−	−	−	−	−
9301	*O. bolusii*	−	−	−	−	+	+	−	−	−	+	−	−
8403	*O. bracteolata*	+	−	+	−	+	−	+	−	−	−	−	−
8237	*O. brevibracteatum*	+	+	+	+	+	+	+	+	−	+	−	−
1579	*O. caffrum*	+	−	+	−	+	−	−	−	−	+	−	+
8446	*O. candicans*	+	−	+	+	+	+	+	−	+	+	−	−
9497	*O. candicans*	+	−	−	−	+	+	+	−	+	+	−	−
8442	*O. fruticans*	+	+	+	+	+	+	+	+	−	−	−	−
10555	*O. gazense*	+	+	+	+	+	+	+	+	−	+	−	−
4832	*O. hirtum*	+	+	+	+	+	+	+	+	+	+	−	−
8425	*O. hirtum*	+	+	+	+	+	+	+	+	+	+	−	−
9360	*O. hirtum*	−	−	+	+	+	+	+	−	−	−	−	−
9089	*O. obliquum*	+	−	+	+	+	+	+	−	−	+	−	−
9090	*O. parviflorum*	+	−	+	−	+	+	+	+	+	+	−	−
9369	*O. rotundifolium*	+	−	−	−	+	+	−	−	+	+	−	−
9121	*O. salignum*	−	+	−	+	+	+	+	−	−	+	−	−
9629	*O. sericeum*	+	−	+	+	+	−	+	+	−	−	−	−
8363	*O. spicata*	+	+	+	+	+	+	+	−	+	+	−	−
9307	*O. stachydis*	−	−	+	+	+	+	+	+	−	+	−	−
9620	*O. stachyenum*	+	−	+	+	+	+	+	−	−	+	−	−
8447	*O. striata*	+	+	+	+	+	+	+	−	+	+	−	−
8444	*O. uncinata*	+	+	+	−	+	+	+	−	−	+	−	−
8913	*O. wilmsii*	+	−	+	−	+	+	−	−	+	+	−	+
9093	*O. zeyheri*	−	−	−	−	+	+	+	−	−	+	−	−
8923	*O.* sp.	+	+	+	+	+	+	+	−	−	+	−	−
9999	*Cullen obtusifolia*	−	−	−	−	−	−	−	−	−	−	−	−

*For compound key, see Table 2, + = present, − = absent.

TABLE 2. PERCENTAGE OCCURRENCE OF FLAVONOIDS IN *CULLEN, PSORALEA* AND *OTHOLOBIUM*

Spot No.	Compound	No. of records in species examined (%)	No. of records in species of *Otholobium* (%)	No. of records in species of *Psoralea* (%)
1	Luteolin 7-*O*-glucoside	62 (82)	17 (81)	26 (90)
2	Apigenin *O*-glycoside	19 (25)	9 (43)	9 (31)
3	Orientin	65 (86)	18 (86)	25 (86)
4	Flavone *O*-glycoside	60 (79)	13 (62)	27 (93)
5	Di-*C*-glycosylapigenin	64 (84)	21 (100)	28 (97)
6	Various di-*C*-glycosides of luteolin or chrysoeriol	61 (80)	20 (95)	25 (86)
7	Isoorientin	65 (86)	18 (86)	25 (86)
8	Isovitexin	20 (26)	7 (33)	10 (34)
9	Unidentified (flavone?)	37 (49)	7 (33)	20 (69)
10	Isoorientin *O*-glycoside	63 (83)	18 (86)	26 (90)
11	Rutin	3 (4)	0 (0)	3 (10)
12	Flavone *O*-glycoside	3 (4)	2 (10)	1 (0.3)

Total No. of species = 51; total No. of records = 76; total species *Otholobium* = 21; total species *Psoralea* = 29; total species *Cullen* = 1; in some species more than one accession was examined.

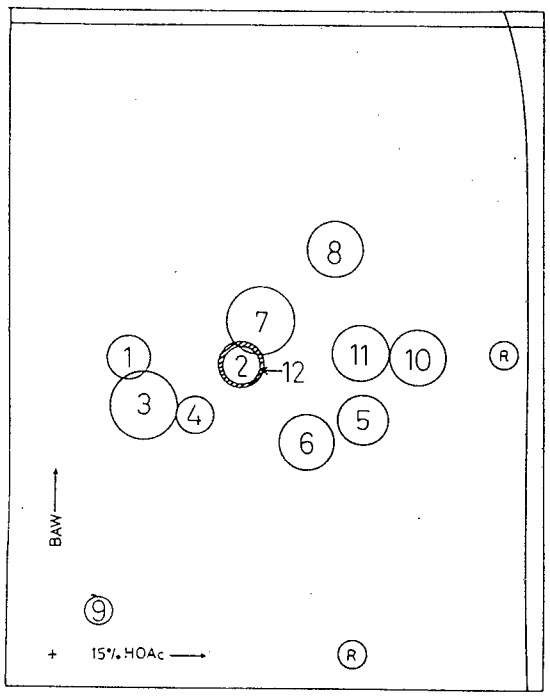


FIG. 1. COMPOSITE 2-DIMENSIONAL PAPER CHROMATOGRAM OF FLAVONOIDS IN SPECIES EXAMINED. Compound/spot No.: 1 luteolin 7-glucoside; 2 apigenin glyc?; 3 orientin; 4 flavone glyc.; 5 di-*C*-glycosylapigenin; 6 di-*C*-glycosyl-luteolin (or chrysoeriol); 7 isoorientin; 8 isovitexin; 9 unidentified; 10 isoorientin *O*-glycoside?; 11 quercetin 3-rutinoside (rutin); 12 flavone glyc.; R rutin marker. BAW (1st solvent)—*n*-butanol–HOAc–H_2O; 4:1:5 top layer. 15% HOAc (2nd solvent)—15% aqueous acetic acid. N.B. Spots 2 and 12 (shaded) occur in the same position, but are recognizable by their colour reactions (see Table 7).

The flavonoid 2D patterns of dried flowers taken from 26 species were generally rather similar, except for *P. repens* which once again had an anomalous pattern and was also the only species to contain rutin (Table 3). *Otholobium* had high concentrations of two flavonoids (9F and 12F) which were very scarce or absent in *Psoralea*. The species *O. bolusii* was characterized by an unknown flavonoid (3F). This species also has a unique leaf 2D pattern. It was not possible to identify the flavonoids as there was insufficient floral material available.

Proanthocyanidins and Isoflavones

Hydrolysed extracts of leaf material were analysed for the presence of proanthocyanidins and isoflavones. Plants which were rich in proanthocyanidins, indicated by a red colour on acid hydrolysis, were analysed further to determine which constituent anthocyanidins were present as condensed tannins. These results are shown in Table 4.

Proanthocyanidins occur in 37 of the species investigated. Prodelphinidin was present in all 37 species. Those species which consistently stained dark red on acid hydrolysis nearly always had traces of procyanidin. Larger concentrations of procyanidin were found in *Psoralea asarina, P. imbricata* and *P.* sp. (accession No. 9627). These oligomers are absent from *Cullen obtusifolia* and all Otholobiums, except for the distinctive *O. sericeum*.

TABLE 3. FLAVONOIDS PRESENT IN FLOWER PETAL EXTRACTS OF *PSORALEA* AND *OTHOLOBIUM* SPECIES

Voucher No.	Spp.	Compound No. 1F	2F	3F	4F	5F	6F	7F	8F	9F	10F	11F	12F	13F	14F	15F	Anthocyanins present
8746	*P. aculeata*	+	+	–	+	+	+	+	–	+	–	–	–	–	–	–	–
9718	*P. affinis*	+	+	–	+	+	+	–	+	+	+	–	–	–	–	–	Dp, Pt
8250	*P. arborea*	+	+	–	+	+	–	+	–	–	+	–	–	–	+	–	Dp, Pt
9736 }	*P. arborea* ×	+	+	–	+	+	–	+	–	–	–	–	–	+	–	–	Dp, Pt
9737 }	*P. effusa*	+	+	–	+	+	–	+	–	–	+	–	–	+	–	–	Dp, Pt
8256	*P. axillaris*	+	+	–	+	+	–	+	–	–	+	–	–	–	+	–	Pt
8258	*P. odoratissima*	+	+	–	+	+	–	+	+	–	+	–	–	–	+	–	Dp, Pt
8219	*P. oligophylla*	+	+	–	+	+	+	+	–	?	–	–	–	–	–	–	Dp, Pt
8297	*P.* cf *pinnata*	+	+	–	+	+	+	+	?	+	+	–	+	–	–	–	Dp, Pt
9742	*P.* sp. cf *pinnata*	+	+	–	+	+	–	+	–	–	+	+	–	–	–	–	Dp, Pt
—	*P. repens**	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	Dp, Pt
9681	*P. speciosa*	+	+	–	–	+	+	+	+	–	+	–	–	–	+	–	Pt
9301	*O. bolusii*	+	+	+	–	–	–	+	–	+	–	–	+	–	–	+	Pt
8403	*O. bracteolata*	+	+	–	+	+	–	+	–	+	+	+	+	+	–	–	Pt
8237	*O. brevibracteatum*	+	+	–	+	+	+	+	–	+	+	+	+	–	–	–	Dp, Pt
1579	*O. caffra*	+	+	–	+	–	–	+	–	+	–	–	+	–	–	–	—
8446	*O. candicans*	+	+	–	+	+	?	+	–	+	+	–	+	–	–	–	Dp, Pt
8422	*O. fruticans*	+	+	–	+	+	–	+	–	–	+	+	–	+	–	–	Dp, Pt
4832	*O. hirtum*	+	+	–	+	+	–	+	–	+	+	+	+	–	–	–	Dp, Pt
8425	*O. hirtum*	+	+	–	+	+	–	+	–	+	+	–	+	–	–	–	—
8447	*O. striata*	+	–	–	?	–	?	+	–	+	–	–	+	–	–	–	Pt
8444	*O. uncinata*	+	+	–	–	–	+	+	–	+	–	–	+	–	–	–	Dp, Pt
8913	*O. wilmsii*	+	+	–	+	+	–	+	–	+	+	+	–	–	–	–	Dp, Pt

Key: + = present; – = absent; Dp, delphinidin glycosides present; Pt, petunidin glycosides present; 1F luteolin 7-glucoside; 2F chrysoeriol glycoside.

*Flowers of *P. repens* also contained rutin.

Three isoflavones which occur widely in the Papilionoideae were detected in hydrolysed leaf extracts: daidzein, genistein and formononetin. Daidzein has previously been reported in *P. corylifolia* roots along with several isopentenyl isoflavonoids [13], but genistein and formononetin have not been described before from *Psoralea* s.l. Since these isoflavones were generally present in all those taxa examined (Table 4), they did not appear to have any taxonomic significance so they were not further considered.

Furanocoumarins

The results of examining hydrolysed extracts of leaf material for furanocoumarins is given in Table 5. Psoralen and angelicin were the only two compounds identified, but other furanocoumarins were also present (cf. Table 6). Psoralen occurs in all species of *Otholobium* and *Psoralea*, except for *P. repens* and *P. tenuifolia*. It does not occur in *Cullen*. Angelicin is present only in *P. affinis* and *O. rotundifolium*.

Essential Oils

Many of the plants surveyed have recognizably different odours and appear to contain volatile oils in special leaf glands. Results from a preliminary survey of essential oils in the tribe using TLC would suggest that the chemicals present provide good generic markers (Table 5 and Fig. 2). *Psoralea* is characterized by the combined presence of oils C, D and E. *Otholobium*, on the other hand, has a richer pattern of essential oils (compounds A–G) and although more types of oil are produced than in *Psoralea* it is still unclear whether there are any meaningful patterns within the genus. The genus warrants a broader study. The essential oil D, it should be pointed out, occurs in all

TABLE 4. PRESENCE OF PROANTHOCYANIDINS AND ISOFLAVONES IN HYDROLYSED EXTRACTS OF *CULLEN, OTHOLOBIUM* AND *PSORALEA*

Voucher No.	Spp.	Presence/absence of proanthocyanidins	Type of proanthocyanins present	Isoflavones present (where examined)
8746	*P. aculeata*	++	Dp	Da, Gen
9605	*P. affinis*	++	Dp	N.E.
9623	*P. affinis*	+	Dp	N.E.
9718	*P. affinis*	tr	Dp	N.E.
8250	*P. arborea*	++	Dp	Da, Gen
9740	*P. arborea*	+++	Dp, Cy	N.E.
9736	*P. arborea* ×	++	Dp, Cy	N.E.
9737	*P. effusa*	++	Dp, Cy	N.E.
8420	*P. asarina*	++	Dp, Cy	Da
8256	*P. axillaris*	+	N.E.	Gen
9163	*P. connixa*	tr	Dp	N.E.
9183	*P. connixa*	+	Dp	N.E.
9526	*P. connixa*	+	Dp	N.E.
8220	*P. effusa*	++	Dp	Da, Gen
9102	*P. effusa*	++	Dp, Cy	N.E.
9478	*P. effusa*	++	Dp	N.E.
9712	*P. effusa*	++	Dp, Cy	N.E.
9739	*P. effusa*	+++	Dp, Cy	N.E.
9509	*P. exile*	+	Dp	N.E.
9521	*P. exile*	++	Dp	N.E.
9602	*P. glabra*	+++	Dp, Cy	N.E.
8333	*P. imbricata*	++	Dp, Cy	Da
8211	*P. laxa*	++	Dp	Da, Gen
8093	*P. nodosa*	+	N.E.	Da
8445	*O. bolusii*	tr	N.E.	Da, Gen
9301	*O. bolusii*	+	Dp	N.E.
8403	*O. bracteolata*	–	–	Da, Gen, F
8237	*O. brevibracteatum*	–	–	Da, Gen, F
1579	*O. caffra*	tr	N.E.	Da?
8446	*O. candicans*	–	–	Da, Gen
9497	*O. candicans*	–	–	N.E.
8422	*O. fruticans*	–	–	Da
10555	*O. gazense*	tr	N.E.	N.E.
4832	*O. hirtum*	–	–	Da, Gen
8425	*O. hirtum*	–	–	Da
9360	*O. hirtum*	–	–	N.E.
9999	*Cullen obtusifolia*	–	–	N.E.
8258	*P. odoratissima*	tr	–	Gen
8219	*P. oligophylla*	++	Dp	Da, Gen
9184	*P. oreopolum*	tr	Dp	N.E.
9818	*P. oreopolum* × *P. ramulosa*	tr	Dp	N.E.
9185		tr	Dp	N.E.
9186		tr	Dp	N.E.
9562	*P. papillosa*	+	Dp	N.E.
8479	*P. pinnata*	++	Dp	Da
9757	*P. pinnata*	+	Dp	N.E.
8297	*P.* sp. cf *pinnata*	+	N.E.	Da, Gen, F
9292	*P.* sp. cf *pinnata*	++	Dp, Cy	N.E.
9742	*P.* sp. cf *pinnata*	+++	Dp	N.E.
9451	*P. pullata*	++	Dp, Cy	N.E.
9142	*P. ramulosa*	+	Dp	N.E.
—	*P. repens*	tr	Dp	N.E.

TABLE 4—*CONTINUED*

Voucher No.	Spp.	Presence/absence of proanthocyanidins	Type of proanthocyanins present	Isoflavones present (where examined)
8413	*P. repens*	–	–	Da, Gen
9441	*P. repens*	tr	Dp	N.E.
9681	*P. speciosa*	+	Dp	N.E.
9709	*P. speciosa*	++	Dp, Cy	N.E.
105	*P. tenuifolia*	+	N.E.	Da, Gen, F
9187	*P. tenuifolia*	tr	Dp	N.E.
9506	*P. tenuifolia*	+	Dp	N.E.
9715	*P. tenuifolia*	+	Dp	N.E.
9367	*P. verrucosa*	++	Dp, Cy	N.E.
9627	*P.* sp.	++	Dp, Cy	N.E.
9708	*P.* sp. nov.	tr	Dp	N.E.
9089	*O. obliquum*	–	–	N.E.
9090	*O. parviflorum*	–	–	N.E.
9369	*O. rotundifolium*	–	–	N.E.
9121	*O. salignum*	–	–	N.E.
9629	*O. sericeum*	++	Dp, Cy	N.E.
8363	*O. spicata*	tr	N.E.	Da, Gen, F
9307	*O. stachydis*	–	–	N.E.
9620	*O. stachyerum*	–	–	N.E.
8447	*O. striata*	–	–	Da, Gen
8444	*O. uncinata*	+	N.E.	Da, Gen, F
8913	*O. wilmsii*	–	–	Da, Gen
9093	*O. zeheri*	++	N.E.	N.E.
8923	*O.* sp.	–	–	Da, Gen

Key: + = presence; – = absence; tr = trace present; N.E. = not examined; Dp = prodelphinidin; Cy = procyanidin; Da = daidzein; Gen = genistein; F = formononetin.

species of the tribe studied so far, except in *O. hirtum*.

Discussion

The significance of the taxonomic value of chemical data for the identification and classification of the African Psoraleeae can be seen in Fig. 3. The two main genera *Psoralea* and *Otholobium* form distinct groups. The diagram also highlights the distinctiveness of *P. repens*. Unfortunately only *Cullen obtusifolia*, one of the six African *Cullen* species, was available for study. This genus is widespread in south-east Asia and Australasia, and given the apparent chemical distinctness of *C. obtusifolia* would merit a detailed chemical study.

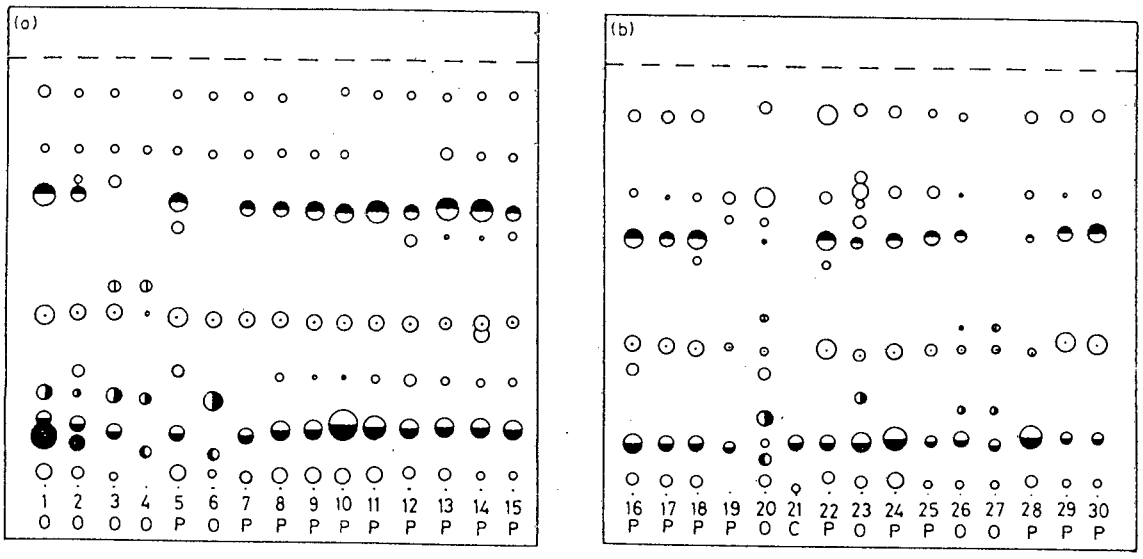
The most striking chemical differences between the genera lie in their as yet unidentified essential oils. The essential oils found in *Psoralea* occur universally in that genus, quite unlike the situation in *Otholobium* where there is a greater diversity of different oils. These need to be studied in more depth across the genus as they promise some valuable taxonomic markers and could be useful in unravelling the phylogeny of the group.

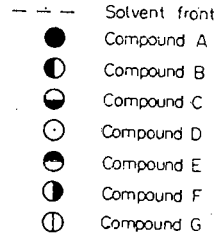
Another important chemical difference between the genera is the almost total absence of proanthocyanidins in *Otholobium*. This is a particularly interesting finding as one of us (C.H.S.) has observed in the field that *Psoralea* is rarely eaten by herbivores whereas *Otholobium* is. There is already evidence to suggest that proanthocyanidins are anti-feedants. Two examples are the inhibition of feeding on winter moth larvae in oak leaves [14] and cattle

TABLE 5. DISTRIBUTION OF FURANOCOUMARINS AND ESSENTIAL OILS IN LEAF EXTRACTS

Voucher No.	Spp.	Furanocoumarins a	b	c	d	Essential Oils A	B	C	D	E	F	G
9605	*P. affinis*	+	+	+	+	–	–	+	+	+	–	–
9623	*P. affinis*	++	++	+	+	–	–	+	+	+	–	–
9718	*P. affinis*	+	–	+	+	–	–	+	+	+	–	–
9740	*P. arborea*	++	+	–	+	–	–	+	+	+	–	–
9736	*P. arborea* ×	+	+	–	++	–	–	+	+	+	–	–
9737	*P. effusa*	+	+	–	+	–	–	+	+	+	–	–
9163	*P. connixa*	++	+	+	–	–	–	+	+	+	–	–
9183	*P. connixa*	++	++	+	+	–	–	+	+	+	–	–
9526	*P. connixa*	++	+	+	–	–	–	+	+	+	–	–
9102	*P. effusa*	++	++	–	+	–	–	+	+	+	–	–
9478	*P. effusa*	++	+	–	+	–	–	+	+	+	–	–
9712	*P. effusa*	+	+	–	++	–	–	+	+	+	–	–
9739	*P. effusa*	++	++	+	+	–	–	+	+	+	–	–
9509	*P. exile*	+	+	+	–	–	–	+	+	+	–	–
9521	*P. exile*	+	+	–	–	–	–	+	+	+	–	–
9602	*P. glabra*	++	++	++	–	–	–	tr	+	tr	–	–
9184	*P. oreopolum*	+	+	+	+	–	–	+	+	+	–	–
9185	*P. oreopolum* ×	+	+	+	+	–	–	+	+	+	–	–
9186	*P. ramulosa*	++	+	+	–	–	–	+	+	+	–	–
9187												
9562	*P. papillosa*	+	+	+	++	–	–	–	+	+	–	–
9757	*P. pinnata*	–	+	+	+	–	–	–	+	+	–	–
9292	*P.* sp. cf *pinnata*	++	+	+	–	–	–	+	+	+	–	–
9742	*P.* sp. cf *pinnata*	+	+	–	+	–	–	–	+	+	–	–
9451	*P. pullata*	+	+	++	–	–	–	–	+	+	–	–
9142	*P. ramulosa*	+	+	+	++	–	–	–	+	+	–	–
—	*P. repens*	–	+	++	+	–	–	–	+	+	tr	–
9441	*P. repens*	–	+	+	+	–	–	–	tr	tr	–	–
9681	*P. speciosa*	+	+	+	–	–	–	+	+	+	–	–
9709	*P. speciosa*	++	+	+	–	–	–	tr	+	+	–	–
9187	*P. tenuifolia*	+	+	+	+	–	–	+	+	+	–	–
9506	*P. tenuifolia*	+	+	+	–	–	–	+	+	+	–	–
9715	*P. tenuifolia*	+	+	+	–	–	–	+	+	+	–	–
9367	*P. verrucosa*	–	+	+	–	–	–	+	+	+	–	–
9627	*P.* sp.	++	+	+	+	–	–	tr	tr	tr	–	–
9708	*P.* sp.	++	+	+	+	–	–	+	+	+	–	–
9301	*O. bolusii*	++	+	++	++	–	–	–	+	+	tr	–
9497	*O. candicans*	–	+	++	++	–	tr	–	+	tr	+	+
10555	*O. gazense*	+	+	++	++	–	–	+	+	+	?	–
9360	*O. hirtum*	+	+	++	–	–	–	?	–	+	+	tr
9089	*O. obliquum*	+	+	+	+	+	–	+	+	tr	+	–
9090	*O. parviflorum*	++	+	–	–	–	–	+	tr	tr	+	+
9369	*O. rotundifolium*	++	–	–	++	+	–	+	+	+	+	–
9121	*O. salignum*	+	+	++	++	–	tr	–	+	–	+	tr
9629	*O. sericeum*	++	++	+	–	–	tr	–	tr	–	–	–
9307	*O. stachydis*	+	+	+	+	–	+	–	tr	–	tr	tr
9620	*O. stachyenum*	+	+	+	+	–	–	+	+	–	–	–
9093	*O. zeyheri*	+	+	+	–	–	tr	–	tr	–	+	+
9999	*Cullen obtusifolia*	–	+	++	+	–	–	–	tr	–	–	–

Key: + = present; ++ = present as major component; – = absent; tr = trace.





No		No.	
1	*O. rotundifolium*	16	*P. effusa*
2	*O. obliqua*	17	*P. arborea*
3	*O. parviflorum*	18	*P.* sp. cf *pinnata*
4	*O. zeyheri*	19	*P.* sp.
5	*P. effusa*	20	*O. hirtum*
6	*O. sclignum*	21	*C. obtusifolia*
7	*P. ramulosa*	22	*P. pinnata*
8	*P. verrucosa*	23	*O. gazense*
9	*P. connixa*	24	*P. repens*
10	*P. connixa*	25	*P.* sp. cf *pinnata*
11	*P. oreopotum*	26	*O. bolusii*
12	*P. oreopotum* x *P. ramulosa*	27	*O. stachydis*
13	" "	28	*P. repens*
14	" "	29	*P. pullata*
15	*P.* sp. cf *pinnata*	30	*P. effusa*

FIG. 2. DIAGRAMMATICAL REPRESENTATION OF ESSENTIAL OIL RESULTS ON TLC PLATES. P, *Psoralea*; O, *Otholobium*; C, *Cullen*.

TABLE 6. PROPERTIES OF FURANOCOUMARINS AND ESSENTIAL OILS IN LEAF EXTRACTS

(i) Furanocoumarin data		
Spot on TLC plate	Colour on spraying with 5% KOH in MeOH	Identity (if known)
a	green	angelicin
b	purple	psoralen
c	yellow	—
d	blue-green	—
(ii) Essential oil data		
Spot on TLC plate	$-R_f \times 100$ (in hexane:chloroform 3:2)	Colour with Vanillin/H_2SO_4 spray
A	10	dark purple
B	10	blue
C	15	green
D	40	pink
E	60	blue
F	30	purple
G	42	blue

(See also Fig. 2).

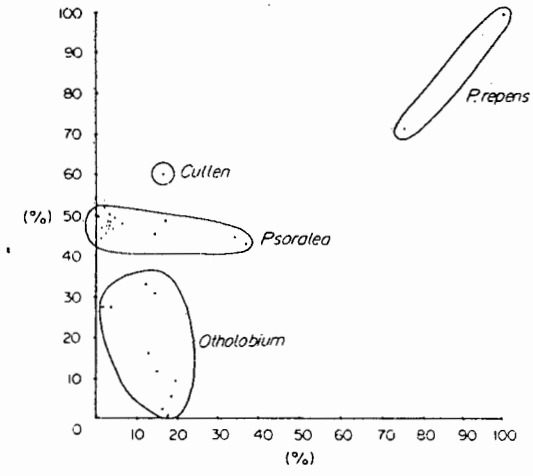


FIG. 3. RECIPROCAL AVERAGING OF CHEMICAL DATA.

browsing in *Lespedeza cuneata* [15], both of which were affected by variations in tannin levels.

This study began with the hypothesis that different classes of chemical compounds, from the same organ, should provide different levels of taxonomic information. It is clear that the chemical data obtained from this survey of the Psoraleeae supports the hypothesis. Thus, while furanocoumarins and flavonoids are most significant at the species level, essential oils and proanthocyanidins are more useful at the generic level. Isoflavones, which are entirely uniform within the group are probably only meaningful at tribal level. The importance therefore of studying a range of chemical characters in a chemotaxonomic study cannot be overstressed.

Experimental

Plant material. Dried plant material, collected by the second author (C.H.S.), was donated by the Botanical Research Institute, South Africa. Details are given in Table 1. Herbarium vouchers are housed in PRE and STE.

Flavonoids

Flavone/flavonol glycosides. These were initially examined by 2-dimensional P.C. in BAW (*n*-butanol–acetic acid–water, 4:1:5, top layer) and 15% aqueous acetic acid (see Fig. 1) using aqueous ethanolic extracts of dried leaf material. To identify the spots large scale separation of crude extracts of several species was carried out on 3 mm paper, variously in

TABLE 7. R_f, SPECTRAL AND COLOUR DATA FOR FLAVONOIDS IN *PSORALEA* (SEE ALSO FIG. 1).

Compound No.	λ_{max} (nm) in MeOH	$R_f \times 100$ in BAW	H_2O	15% HOAc	PhOH	Colour UV	UV + NH_3
1	256, 268, 349	48	—	18	—	dk	br yellow
2	272, 338	38	—	36	—	dk	yellow
3	269, 349	35	04	13	42	dk	dull yellow
4	272, 333	30	—	28	—	l blue	blue yellow
5	273, 334	35	15	40	75	dk	dull yellow
6	273, 345	32	—	45	—	dk	yellow
7	271, 349	51	07	30	65	dk	dull yellow
8	270, 333	58	—	60	—	dk	dull yellow
9	—	—	—	—	—	dk	l yellow
10	273, 335	50	46	71	—	dk	dull brown yellow
11	257, 358	46	—	55	—	dk	yellow
12	270, 342	45	—	34	—	l blue	blue yellow

br = bright; l = light; dk = dark absorbing.

BAW, 15% HOAc, CAW 1:1:0.1 ($CHCl_3$–HOAc–H_2O). Purified compounds were identified by standard methods (UV spectroscopy, R_f data, hydrolysis in 2 N HCl at 100° and analysis of products) and compared with authentic markers when available. See Table 7 for R_f data and colour reactions.

Isoflavones and proanthocyanidins. Hydrolysed extracts only were used. Dried leaf material was hydrolysed at 100° with 2 N HCl for 30 min. Isoflavones were extracted into EtOAc and run on silica gel GF 254 (Merck) TLC plates in 11% MeOH in $CHCl_3$. Identification was confirmed by running extracts as a small streak in the above system, eluting the isoflavone and comparison with authentic markers and UV spectroscopy. Proanthocyanidins were extracted from hydrolysed extracts (as above) into amyl alcohol. The presence or absence of proanthocyanidin was determined by a characteristic red colour on hydrolysis. Further analysis of species with a strong red extract was performed on microcrystalline cellulose plates in Forestal (HOAc–H_2O–HCl, 30:10:3) and co-chromatography with delphinidin and cyanidin.

Furanocoumarins. Hydrolysed extracts were partitioned with EtOAc, and the resulting extracts chromatographed on silica gel plates in Et_2O–toluene–15% HOAc (1:1:1), top layer). The colours of the spot patterns obtained were intensified by spraying with 10% KOH in MeOH. Separation of psoralen and angelicin was carried out by preparative TLC on fluorescent silica gel plates in CH_2Cl_2, followed by further purification in hexane–EtOAc–MeOH (5:5:1). These were identified by UV spectra, colour reactions and MS data [16, 17].

Psoralen, λ_{max} 242, 247, 291, 330 nm fluorescent blue in UV, intense blue+KOH, MS $[M]^+$ 186 ($C_{11}H_6O_3$ requires 186) $[M-CO]$ 158. Angelicin λ_{max} 243, 247, 299, 325 sh nm dull absorbing in UV, bright green+KOH, MS $[M]^+$ 186 ($C_{11}H_6O_3$ requires 186) $[M-CO]$ 158.

Essential oils. Crushed dried leaf material was extracted with Et_2O for 30 min, and the resultant extract chromatographed on silica gel plates in hexane–$CHCl_3$ (3:2). Developed plates were then sprayed with vanillin/H_2SO_4 reagent and heated to 105°. Compounds were recognized by their colour after spraying (Table 6). None of the spots corresponded with any of the commonly available mono- or sesquiterpenoids.

Further investigation of the major *Psoralea* essential oil was carried out. Compound C which gave a green colour with vanillin/H_2SO_4 spray, was purified on silica gel TLC plates in hexane–$CHCl_3$ 3:2. It had UV maximum at 262 nm, and IR spectra in $CHCl_3$ showed absorption bands at 1050, 1215, 2970, 2950 and 3030 cm^{-1}. It gave no colour reaction with 2.4 DNP, $FeCl_3$ or bromocresol blue, but reduced potassium permanganate solution. It could not be further characterized.

Acknowledgement—The authors thank Mr R. Butters of Tate & Lyle Research for mass spectral analyses.

References

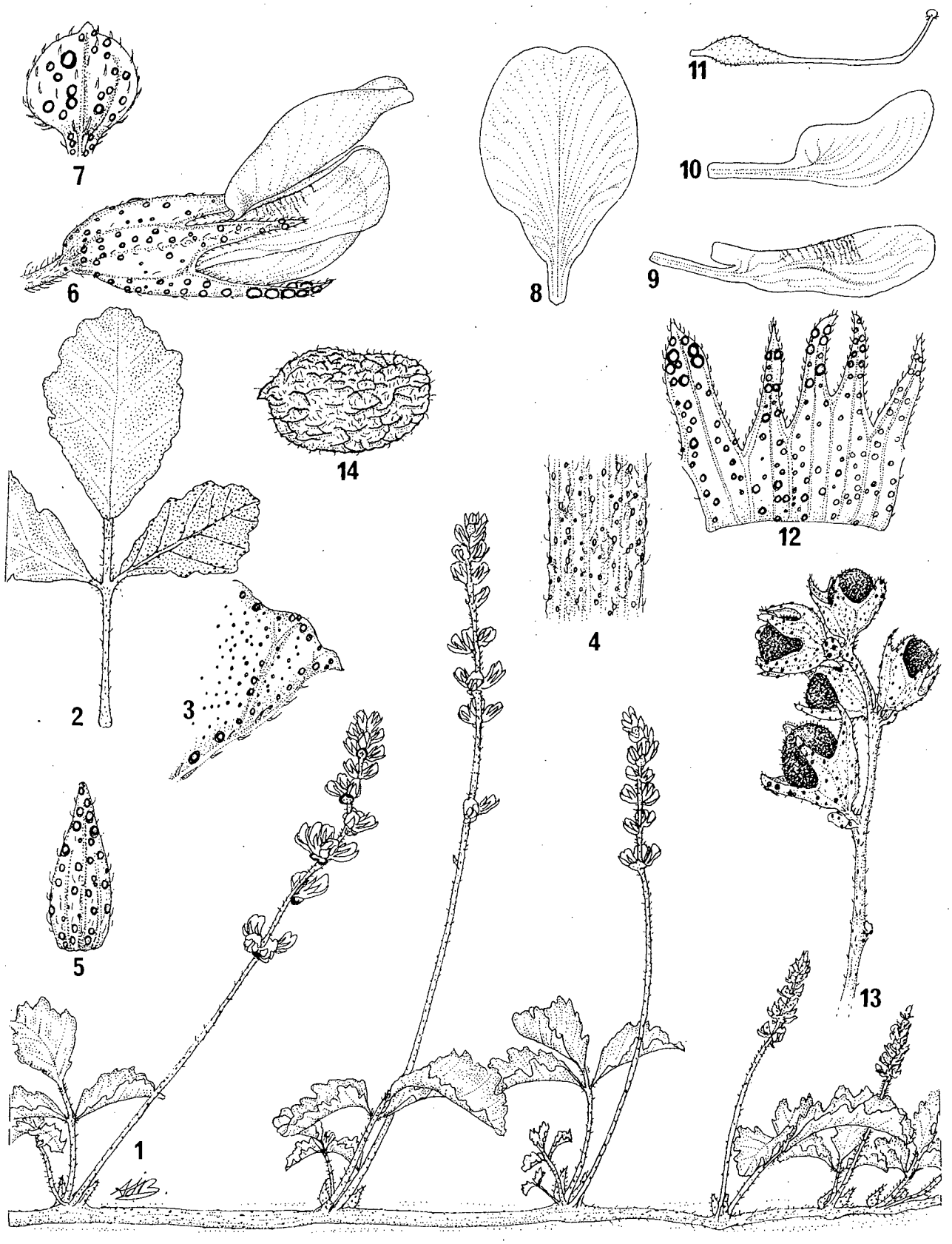
1. Stirton, C. H. (1981) in *Advances in Legume Systematics* (Polhill, R. M. and Raven, P. H., eds) pp. 337–343. Royal Botanic Gardens, Kew.
2. Bentham, G. (1865) *Genera Plantarum*, Vol. 1. Reeve, London.
3. Candolle, A. P. de (1825) *Memoires sur la Famille de Legumineuses*. Belin, Paris.
4. Meyer, E. H. F. (1836) *Commentarium de Plantis Africae Australis*. Berlin.
5. Ecklon, C. F. and Zeyher, C. (1836) *Enumeratio Plantarum Africae Australis Extratropicae*. Leipzig.
6. Ockenden, D. J., Alston, R. E. and Naifeh, K. (1965) *Phytochemistry* **5**, 601.
7. Rydberg, P. A. (1919) *North American Flora* **24**, 1.
8. Harborne, J. B. (1971) *Chemotaxonomy in the Leguminosae* (Harborne, J. B., Boulter, D. and Turner, B. L., eds) pp. 31–71. Academic Press, London.
9. Baskin, J. M. and Murrell, J. T. (1968) *J. Tennessee Acad. Sci.* **43**, 25.
10. Baskin, J. M., Ludlow, C. J., Harris, T. M. and Wolf, F. T. (1967) *Phytochemistry* **6**, 1209.
11. Baskin, J. M., Murrell, J. T. and Wolf, F. T. (1967) *Phyton* **24**, 85.
12. Ivie, G. W. (1978) *J. Agric. Food Chem.* **26**, 1394.
13. Ingham, J. L. (1983) *Fortschr. d. Chem. Org. Naturst.* **43**, 1.
14. Feeny, P. (1970) *Ecology* **51**, 565.
15. Cooper-Driver, G. *et al.* (1977) *Biochem. Syst. Ecol.* **5**, 177.
16. Steck, W. and Bailey, B. K. (1969) *Can. J. Chem.* **47**, 2425.
17. Murray, R. D. H., Mendez, J. and Brown, S. A. (1980) *The Natural Coumarins*. Wiley, Chichester.

APPENDIX 14

Black and white illustrations of the southern African representatives of the genus *Cullen*.

A synopsis of *Cullen* (pro parte) in South Africa is given in Appendix 6.

1. *Cullen holubii* (Burtt Davy) Stirton
2. *Cullen biflora* (Harv.) Stirton
3. *Cullen obtusifolia* (DC.) Stirton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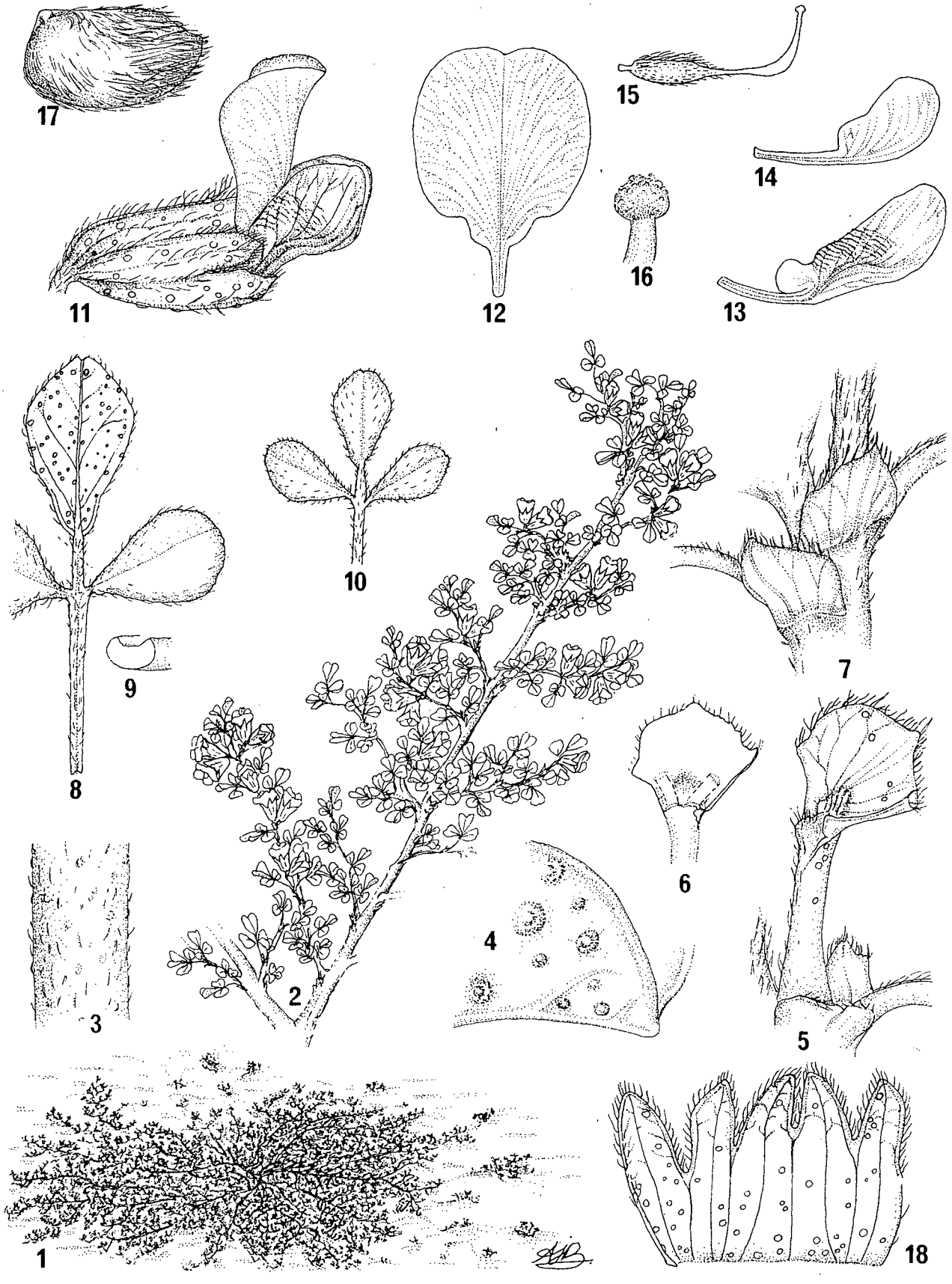
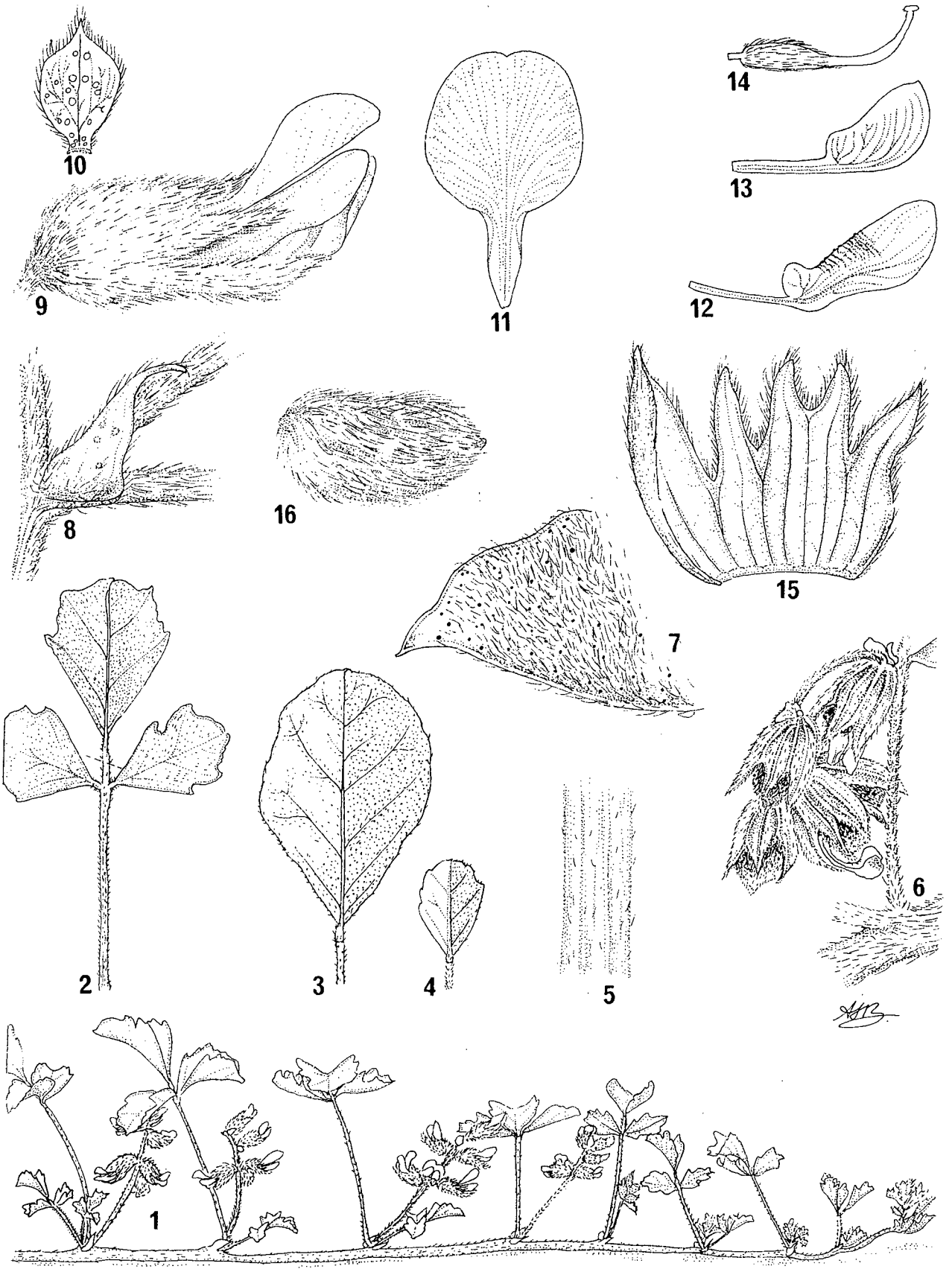
Cullen biflora (Harv.) Stirton



Cullen obtusifolia (DC.) Stirton



APPENDIX 15

Table 2.1

Complete list of DELTA format characters for *Otholobium* used in key-making and for description writing (Table 2.1).

Table 2.1 Complete list of DELTA format characters for Otholobium used in key-making and description writing.

***SHOW: The genus Otholobium (Psoraleeae, Papilionoideae). Revised 13-JUL-87.**

***CHARACTER LIST**

```
1.01    #1. <habit of plant>/
1.02          1. trees/
1.03          2. large shrubs <more than 1m tall>/
1.04          3. small shrubs <less than 1m tall>/
1.05          4. herbs/

2.01    #2. <height>/
2.02          cm tall/

3.01    #3. <robustness of plant>/
3.02          1. slender/
3.03          2. robust/

4.01    #4. <regeneration after fires>/
4.02          1. coppicing after burns/
4.03          2. not coppicing after burns/

5.01    #5. <aggregation of individuals>/
5.02          1. colonial/
5.03          2. scattered/

6.01    #6. <clumping habit>/
6.02          1. forming dense clumps/
6.03          2. never forming dense clumps/

7.01    #7. <type of root system>/
7.02          1. rhizomatous <spreading underground stem>/
7.03          2. with woody rootstock/

8.01    #8. stems <presence or absence of stems>/
8.02          1. caulescent/
8.03          2. acaulescent/

9.01    #9. stems <habit>/
9.02          1. prostrate/
9.03          2. decumbent/
9.04          3. semi-erect to ascending/
9.05          4. erect/

10.01   #10. stems <number of>/
10.02         1. solitary <one>/
10.03         2. many <more than one>/

11.01   #11. stems <duration>/
11.02         1. herbaceous/
11.03         2. woody only at base/
11.04         3. woody throughout/

12.01   #12. stems vestiture <applicable to young shoots>/
12.02         1. present/
```

12.03 2. absent/

13.01 #13. stems vestiture <density of stem hairs>/
13.02 1. sparse/
13.03 2. moderate/
13.04 3. dense/

14.01 #14. stems vestiture <canescence>/
14.02 1. canescent <covered in a close white or silvery pubescence>/
14.03 2. comprised of brown, yellow or blackish hairs <never
14.04 canescent>/

15.01 #15. stems <striation>/
15.02 1. striate/
15.03 2. smooth/

16.01 #16. stems <glandulosity>/
16.02 1. pustulate <raised pustules on the stems>/
16.03 2. non-pustulate <without raised pustules on stems>/

17.01 #17. stems <point at which branching occurs>/
17.02 1. branching at the base/
17.03 2. branching in lower axils <from just above the base to middle>/
17.04 3. branching in upper axils <from the middle upwards>/
17.05 4. branching all along the stem/

18.01 #18. stem branches <orientation>/
18.02 1. erect/
18.03 2. spreading/

19.01 #19. stem branches <vestiture of branches>/
19.02 1. with vestiture/
19.03 2. without vestiture/

20.01 #20. leaves <reduction of leaves in upper parts to scales>/
20.02 1. scale-like in upper parts <reduced to scales>/
20.03 2. not scale-like <not reduced to scales>/

21.01 #21. leaves <number of pinnae>/
21.02 1. simple/
21.03 2. 1-foliolate/
21.04 3. 2-foliolate/
21.05 4. 3-foliolate/
21.06 5. 4-foliolate/
21.07 6. 5-foliolate/
21.08 7. 7-foliolate/
21.09 8. 9-foliolate/
21.10 9. 11-foliolate/

22.01 #22. leaves <presence of rhachis if trifoliolate>/
22.02 1. digitately trifoliolate/
22.03 2. pinnately trifoliolate/

23.01 #23. leaves <number of leaflets produced as plant ramifies>/
23.02 1. same number of leaflets produced at all stages of growth/
23.03 2. number of leaflets variable at different stages of growth/

24.01 #24. leaves <organization>/
24.02 1. crowded at the ends of bare branches/

24.03 2. distributed along the branches/

25.01 #25. leaves <orientation of the leaves>/
25.02 1. clasping the shoots/
25.03 2. erect/
25.04 3. patent <spreading>/
25.05 4. deflexed/

26.01 #26. terminal leaflets <leaf length>/
26.02 mm long/

27.01 #27. terminal leaflets <leaf width>/
27.02 mm wide/

28.01 #28. leaves <leaf shape>/
28.02 1. very narrowly obovate/
28.03 2. narrowly obovate/
28.04 3. obovate/
28.05 4. broadly obovate/
28.06 5. very broadly obovate/
28.07 6. depressed obovate/
28.08 7. narrowly elliptic/
28.09 8. elliptic/
28.10 9. broadly elliptic/
28.11 10. circular <very broadly elliptic>/
28.12 11. transversely broadly elliptic/
28.13 12. linear/
28.14 13. narrowly oblong/
28.15 14. oblong/
28.16 15. narrowly ovate/
28.17 16. ovate/
28.18 17. broadly ovate/
28.19 18. very broadly ovate/
28.20 19. oblanceolate/

29.01 #29. leaves <folding>/
29.02 1. conduplicate/
29.03 2. partly conduplicate/
29.04 3. displayed <lying flat>/

30.01 #30. leaves <degree of petiolation>/
30.02 1. sub-sessile <less than 2mm>/
30.03 2. petiolate <more than 2mm>/

31.01 #31. leaves <occurrence of stipels>/
31.02 1. stipellate/
31.03 2. without stipels/

32.01 #32. leaflets <shape in transverse section>/
32.02 1. linear in cross-section/
32.03 2. terete or angled in transverse section/

33.01 #33. apex of terminal leaflets/
33.02 1. rounded/
33.03 2. obtuse/
33.04 3. retuse/
33.05 4. emarginate/
33.06 5. acute/
33.07 6. acuminate/

33.08 7. attenuate/

34.01 #34. base of terminal leaflets/
34.02 1. cordate/
34.03 2. rounded/
34.04 3. obtuse/
34.05 4. acute/
35.06 5. cuneate/

35.01 #35. mucro of terminal leaflets <shape>/
35.02 1. straight/
35.03 2. arching/
35.04 3. sharply recurved/

36.01 #36. mucro of terminal leaflets <robustness of mucro>/
36.02 1. narrow <setiferous>/
36.03 2. broad/

37.01 #37. mucro of terminal leaflets <sharpness and stiffness of mucro>/
37.02 1. pungent <sharp>/
37.03 2. blunt/

38.01 #38. leaflet margins <entirety>/
38.02 1. entire/
38.03 2. not entire/

39.01 #39. leaflet margins <if not entire>/
39.02 1. minutely scabrous/
39.03 2. scabrous/
39.04 3. finely crenate/
39.05 4. wrinkled/

40.01 #40. leaflet margins <undulation>/
40.02 1. undulating/
40.03 2. not undulating/

41.01 #41. glands <visibility of glands>/
41.02 1. visible with a x10 hand lens/
41.03 2. not visible with a x10 hand lens/

42.01 #42. glands <colour of glands in dried state>/
42.02 1. black/
42.03 2. yellow or orange/
42.04 3. hyaline/

43.01 #43. glands <density of glands on upper versus lower surface>/
43.02 1. more dense on upper surface/
43.03 2. more or less equal in number on both surfaces/
43.04 3. more dense on lower surface/

44.01 #44. glands <height above the leaf surface>/
44.02 1. distinctly raised above the surface/
44.03 2. flush with the surface/

45.01 #45. lateral leaflets <suppression of laterals>/
45.02 1. laterals suppressed or reduced to minute scales/
45.03 2. laterals always present/

46.01 #46. lateral leaflets <symmetry>/

46.02 1. symmetrical/
46.03 2. asymmetrical/

47.01 #47. lateral leaflets <length relative to terminal leaflet>/
47.02 1. no more than half the length of the terminal leaflet/
47.03 2. half to two thirds the length of the terminal leaflet/
47.04 3. about the same length as the terminal leaflet/

48.01 #48. lateral leaflets <width ratio of two halves as seen from above>/
48.02 1. left half wider/
48.03 2. halves equal/
48.04 3. right half wider/

49.01 #49. lateral leaflets <gibbosity>/
49.02 1. gibbous/
49.03 2. not gibbous/

50.01 #50. immature leaves <vestiture>/
50.02 1. glabrous/
50.03 2. hairy/

51.01 #51. upper surface of mature leaflets <sheen>/
51.02 1. shiny <nitid>/
51.03 2. dull <not shiny>/

52.01 #52. lower surface of mature leaflets <vestiture>/
52.02 1. glabrous/
52.03 2. glabrescent/
52.04 3. minutely scabridous/
52.05 4. finely pubescent/
52.06 5. sparsely sericeous/
52.07 6. canescent/

53.01 #53. petioles <occurrence>/
53.02 1. present <petiolate>/
53.03 2. absent/

54.01 #54. petioles <length of petiole>/
54.02 mm long/

55.01 #55. <length relative to length of terminal leaflets>/
55.02 1. shorter than terminal leaflets/
55.03 2. about equal in length to terminal leaflets/
55.04 3. longer than terminal leaflets/

56.01 #56. stipules <persistence>/
56.02 1. persistent/
56.03 2. caducous/

57.01 #57. stipules <length>/
57.02 mm long/

58.01 #58. stipules <width>/
58.02 mm long/

59.01 #59. stipules <length relative to petiole>/
59.02 1. shorter than petiole/
59.03 2. equal in length to petiole/
59.04 3. longer than petiole/

60.01 #60. stipules <fusion to petiole at the base>/
60.02 1. fused at base to petiole/
60.03 2. free from petiole/

61.01 #61. stipules <shape of stipules>/
61.02 1. subulate/
61.03 2. linear/
61.04 3. lanceolate/
61.05 4. narrowly triangular/
61.06 5. broadly obliquely ovate/

62.01 #62. stipules <orientation of stipules relative to axis of shoot>/
62.02 1. clasping <appressed>/
62.03 2. patent/
62.04 3. recurved/

63.01 #63. stipules <vestiture of stipules>/
63.02 1. glabrous/
63.03 2. hairy/

64.01 #64. inflorescences <occurrence of pseudoracemes>/
64.02 1. pseudoracemes present/
64.03 2. pseudoracemes absent/

65.01 #65. inflorescences <position>/
65.02 1. borne in uppermost axil of short shoot/
65.03 2. borne in upper few axils of short shoots/
65.04 3. borne in most axils of short shoots/

66.01 #66. inflorescences <type of inflorescence>/
66.02 type/

67.01 #67. inflorescences <length of inflorescence at full anthesis>/
67.02 mm long/

68.01 #68. inflorescences <width of inflorescence at full anthesis>/
68.02 mm long/

69.01 #69. inflorescences <congestion of flowers in inflorescence>/
69.02 1. lax/
69.03 2. congested <flowers packed tightly>/

70.01 #70. inflorescences <shape of inflorescence>/
70.02 1. transversely broadly elliptic/
70.03 2. broadly ovate/
70.03 3. oblong/
70.04 4. rounded/

71.01 #71. inflorescences with <number of triplets of flowers in inflorescence>/
71.02 1. one triplet/
71.03 2. 2 - 6 triplets/
71.04 3. more than 10 triplets/

72.01 #72. flowers <number of flowers per inflorescence>/
72.02 per inflorescence/

73.01 #73. flowers <floral maturation>/
73.02 1. maturing more or less simultaneously/

73.03 2. maturing sequentially/

74.01 #74. flowers <length>/
74.02 mm long/

75.01 #75. flowers <flower colour>/
75.02 1. cream/
75.03 2. white/
75.04 3. pink/
75.05 4. mauve/
75.06 5. purple/
75.07 6. light violet/
75.08 7. reddish violet/

76.01 #76. peduncles <stoutness>/
76.01 1. filiform/
76.03 2. stout/

77.01 #77. peduncles <length>/
77.02 mm long/

78.01 #78. peduncles <length of peduncle relative to subtending leaf>/
78.02 1. overtopped by subtending leaves/
78.03 2. about equal in length to subtending leaves/
78.04 3. overtopping subtending leaves/

79.01 #79. peduncle <degree of overtopping of leaf by inflorescence>/
79.02 1. less than twice the length of the subtending leaf/
79.03 2. about twice the length of the subtending leaf/
79.04 3. more than twice the length of the subtending leaf/

80.01 #80. cupulum <occurrence>/
80.02 1. present/
80.03 2. absent/

81.01 #81. cupulum <type>/
81.02 1. bilobed/
81.03 2. bilobed with one of the lobes bilabiate/
81.04 3. trilobed/

82.01 #82. cupulum <vestiture>/
82.02 1. glabrous/
82.03 2. hairy/

83.01 #83. cupulum <development of the lobes>/
83.02 1. lobes equally developed/
83.03 2. one of the lobes scarcely developed/

84.01 #84. cupulum <shape of the lobes>/
84.02 1. setose or linear/
84.03 2. narrowly triangular/
84.04 3. triangular/
84.05 4. broadly triangular/

85.01 #85. glands of cupulum <conspicuousness>/
85.02 1. conspicuous/
85.03 2. not evident/

86.01 #86. pedicels <occurrence of pedicels>/

86.02 1. present <greater than 1 mm long>/
86.03 2. absent <less than 1 mm long>/

87.01 #87. pedicels <length of pedicels>/
87.02 mm long/

88.01 #88. flower triplets <bracteation>/
88.02 1. braceate/
88.03 2. ebracteate/

89.01 #89. the triplet bracts <occurrence>/
89.02 1. present/
89.03 2. absent/

90.01 #90. the triplet bracts <persistence>/
90.02 1. persistent/
90.03 2. caducous/

91.01 #91. the triplet bracts <apex>/
91.02 1. flabellate <toothed or flabellate>/
91.03 2. never flabellate <always with single point>/

92.01 #92. flower bracts <occurrence>/
92.02 1. present/
92.03 2. absent/

93.01 #93. flower bracts <persistence of flower bract>/
93.02 1. absent at anthesis/
93.03 2. persistent during anthesis/

94.01 #94. flower bracts <shape of flower bract>/
94.02 1. linear/
94.03 2. lanceolate/
94.04 3. triangular/
94.05 4. ovate/

95.01 #95. flower bracts <naviculation of flower bract>/
95.02 1. naviculate <boat-shaped>/
95.03 2. not naviculate/

96.01 #96. bracteoles <occurrence>/
96.02 1. present/
96.03 2. absent/

97.01 #97. bracteoles <shape of bracteoles>/
97.02 1. filiform/
97.03 2. lanceolate/

98.01 #98. bracteoles <persistence of bracteoles at anthesis>/
98.02 1. absent at anthesis <early caducous or ebracteolate>/
98.03 2. <present and persistent> persistent at anthesis/

99.01 #99. bracteoles <point of attachment of bracteoles>/
99.02 1. attached to pedicels/
99.03 2. attached to the base of the calyx tube/

100.01 #100. calyx tube <length>/
100.02 mm long/

101.01 #101. calyx teeth <number of times longer than calyx tube>/
101.02 times longer than calyx tube/

102.01 #102. calyx teeth <length of calyx teeth relative to each other>/
102.02 1. equal/
102.03 2. subequal <keel slightly longer>/
102.04 3. unequal <keel much longer>/

103.01 #103. the lateral and vexillar calyx teeth <apex of lateral and vexillar teeth>/
103.02 1. acute/
103.03 2. acuminate/

104.01 #104. the lateral and vexillar calyx teeth <curvature of lateral and vexillar teeth>/
104.02 1. straight/
104.03 2. falcate/

105.01 #105. the lateral and vexillar calyx teeth <shape of lateral and vexillar teeth>/
105.02 1. lanceolate/
105.03 2. triangular/
105.04 3. narrowly triangular/

106.01 #106. the carinal calyx tooth <apex>/
106.02 1. acute/
106.03 2. acuminate and coiled <O.acuminatum>/
106.04 3. pungent/

107.01 #107. the carinal calyx tooth <width relative to other four teeth>/
107.02 1. narrower than other four teeth/
107.03 2. equal in length to other four teeth/
107.04 3. much broader than other four teeth/

108.01 #108. the carinal calyx tooth <length of carinal calyx tooth>/
108.02 mm long/

109.01 #109. the carinal calyx tooth <width of carinal calyx tooth>/
109.02 mm long/

110.01 #110. the vexillar calyx lobes <fusion above the tube>/
110.02 1. fused above the tube/
110.03 2. free above the tube/

111.01 #111. the vexillar calyx lobes <degree of fusion above the tube>/
111.02 1. fused for up to one third of their length above the tube/
111.03 2. fused for one third to one half their length above the tube/
111.04 3. fused for more than half their length above the tube/

112.01 #112. calyx <length of calyx relative to flower length>/
112.02 1. shorter than corolla/
112.03 2. equal in length to the corolla/
112.04 3. longer than the corolla/

113.01 #113. inner face of calyx teeth <presence of vestiture>/
113.02 1. glabrous/
113.03 2. hairy/

114.01 #114. inner face of calyx teeth <density of vestiture>/
114.02 1. densely covered in small black stubby hairs/
114.03 2. sparsely covered in small black stubby hairs/
114.04 3. finely covered in white hairs/

115.01 #115. inner face of calyx teeth <venation>/
115.02 1. prominently reticulate/
115.03 2. not prominently reticulate/

116.01 #116. calyx ribs <degree of thickness of ribbing>/
116.02 1. distinctly thickened/
116.03 2. slender/

117.01 #117. calyx glands <glandulosity of calyx>/
117.02 1. sparse/
117.03 2. dense/

118.01 #118. calyx glands <size of glands on the calyx>/
118.02 1. constant in size/
118.03 2. variable in size/

119.01 #119. calyx glands <distribution of glands on the calyx>/
119.02 1. equally distributed across calyx and tube/
119.03 2. more densely concentrated on the teeth/

120.01 #120. standard petal <length>/
120.02 mm long/

121.01 #121. standard petal <width of the standard>/
121.02 mm wide/

122.01 #122. standard petal <types>/
122.02 type/

123.01 #123. claw of the standard petal/
123.02 claw mm long/

124.01 #124. claw of standard petal/
124.02 1. short and broad/
124.03 2. elongated and narrow/

125.01 #125. standard petal <shape of the standard>/
125.02 1. narrowly elliptic/
125.03 2. elliptic/
125.04 3. broadly elliptic/
125.05 4. orbicular/
125.06 5. narrowly ovate/
125.07 6. ovate/
125.08 7. broadly ovate/
125.09 8. very broadly ovate/
125.10 9. narrowly obovate/
125.11 10. obovate/
125.12 11. broadly obovate/
125.13 12. oblong/

126.01 #126. standard petal <colour of the main limb of the standard, excl. nectar patch>/
126.02 1. white/
126.03 2. cream/
126.04 3. yellow/
126.05 4. pink/
126.06 5. mauve/
126.07 6. purple/
126.08 7. violet/

126.09 8. reddish violet/
126.10 9. blue/

127.01 #127. standard petal <appendages, also called callosities, presence of>/
127.02 1. appendages present/
127.03 2. appendages absent/

128.01 #128. standard petal <occurrence of auricles>/
128.02 1. auricles absent/
128.03 2. auricles weakly developed/
128.04 3. auricles prominent <strongly developed>/

129.01 #129. standard petal <shape of auricles>/

130.01 #130. apex of standard petal <shape of apex of standard>/
130.02 1. rounded or obtuse/
130.03 2. hooded/
130.04 3. emarginate/

131.01 #131. glands on standard petal <glandulosity>/
131.02 1. present on inner face of upper part of blade/
131.03 2. absent/

132.01 #132. standard petal <vestiture>/
132.02 1. present/
132.03 2. absent/

133.01 #133. wing petals <length>/
133.02 mm long/

134.01 #134. wing petals <width>/
134.02 mm wide/

135.01 #135. wing petals <ratio of wing width to wing length>/
135.02 wing width to wing length ratio of/

136.01 #136. wing petals <curvature>/
136.02 1. straight/
136.03 2. upcurving/

137.01 #137. wing petals <occurrence of auricles>/
137.02 1. auricles present/
137.03 2. auricles absent/

138.01 #138. wing petals <length of wing petals relative to keel petals>/
138.02 1. shorter than keel petals/
138.03 2. equal in length to keel petals/
138.04 3. longer than keel petals/

139.01 #139. claw of wing petals <length of claw>/
139.02 mm long/

140.01 #140. wing petals <ratio of wing length to wing claw>/
140.02 wing claw to wing length ratio of/

141.01 #141. wing petals <dilation of blades of wing petal>/
141.02 1. blades dilated past the middle <spathulate>/
141.03 2. blades not dilated beyond the middle/

142.01 #142. wing petals <fusion of wing petal to the keel blades near the auricle>/
142.02 1. fused to keel petals/
143.03 2. free from keel petals/

143.01 #143. petal sculpturing <occurrence>/
143.02 1. present/
143.03 2. absent/

144.01 #144. petal sculpturing <number of lamellae>/

145.01 #145. petal sculpturing <distinction of the rows of lamellae>/
145.02 1. rows distinct/
145.03 2. rows indistinct/

146.01 #146. petal sculpturing <position of sculpturing on the wing petal>/
146.02 1. upper basal/
146.03 2. upper left central/
146.04 3. upper right central/
146.05 4. upper central/
146.06 5. upper distal/

147.01 #147. petal sculpturing <position of sculpturing relative to underlying venation>/
147.02 1. intercostal/
147.03 2. transcostal/
147.04 3. both inter- and transcostal/

148.01 #148. petal sculpturing <type of sculpturing>/
148.02 1. regularly lamellate <straight>/
148.03 2. irregularly lamellate <wavy>/

149.01 #149. keel petals <length>/
149.02 mm long/

150.01 #150. keel petals <width of keel petals>/
150.02 mm wide/

151.01 #151. keel petals <ratio of keel length to keel claw>/
151.02 keel claw to keel length ratio/

152.01 #152. keel petals <ratio of keel length to width of blade>/
152.02 ratio of keel length to width of keel blade/

153.01 #153. <length of claw of keel petals>/
153.02 claw mm long/

154.01 #154. apex of keel petals <apex of blade>/
154.02 type/

155.01 #155. keel petals <shape>/
155.02 type/

156.01 #156. orientation of auricles on keel petals/
156.02 1. more than 90 degrees/
156.03 2. less than 90 degrees/

157.01 #157. androecium <length of staminal tube>/
157.02 mm long/

158.01 #158. filament of vexillar stamen <fusion of vexillar to androecial sheath>/

158.02 1. free from androecial sheath/
158.03 2. fused to androecial sheath along its lower third/
158.04 3. fused to androecial sheath for half its length/

159.01 #159. the androecial sheath <fusion of androecial sheath>/
159.02 1. split adaxially along its entire length/
159.03 2. fused basally, free distally/
159.04 3. free basally, fused distally/

160.01 #160. androecial fenestrae <occurrence of fenestrae>/
160.02 1. present/
160.03 2. absent/

161.01 #161. anthers <length of anthers>/
161.02 mm long/

162.01 #162. intrastaminal nectary <presences>/
162.02 1. present/
162.03 2. absent/

163.01 #163. pistil <length>/
163.01 mm long/

164.01 #164. ovary <length>/
164.02 mm long/

165.01 #165. ovary <vestiture of ovary>/
165.02 1. hairy/
165.03 2. glabrous/

166.01 #166. ovary <vestiture>/
166.02 1. pilose/
166.03 2. finely pubescent/

167.01 #167. ovary hairs <colour of hairs of ovary>/
167.02 1. white/
167.03 2. black/

168.01 #168. ovary hairs <density of hairs on ovary>/
168.02 1. sparse/
168.03 2. dense <shaggy>/

169.01 #169. ovary <presence of club-shaped glands on the ovary>/
169.02 1. glandular/
169.03 2. non glandular/

170.01 #170. ovary glands <denseness of glands>/
170.02 1. sparse/
170.03 2. dense/

171.01 #171. ovary <occurrence of a stipe or gynophore>/
171.02 1. sessile/
171.03 2. stipitate/
171.04 3. resting on a flange of upright tissue/

172.01 #172. style <degree of hairiness>/
172.02 1. hairy between ovary and beginning of entasis/
172.03 2. glabrous between ovary and beginning of entasis/

173.01 #173. style <height of curvature of the style, as defined in fig. x>/
173.02 mm high/

174.01 #174. entasis <occurrence>/
174.02 1. present/
174.03 2. absent/

175.01 #175. entasis <position of entasis along the style>/
175.02 1. widest before the point of flexure/
175.03 2. widest at point of flexure/
175.04 3. widest beyond point of flexure/

176.01 #176. style beyond the point of flexure <sloping angle>/
176.02 1. forward sloping/
176.03 2. erect/
176.04 3. recurved <inflexed to some degree after the entasis>/

177.01 #177. stigma <size>/
177.02 1. small <less than 1 mm>/
177.03 2. large <greater than 1 mm>/

178.01 #178. stigma <vestiture>/
178.02 1. penicillate/
178.03 2. not penicillate/

179.01 #179. fruits <length>/
179.02 mm long/

180.01 #180. fruits <width>/
180.02 mm wide/

181.01 #181. fruits <compression>/
181.02 1. compressed/
181.03 2. swollen/

182.01 #182. fruits <shape>/
182.02 1. rounded/
182.03 2. obovate/
182.04 3. oblong/
182.05 4. hemispherical/
182.06 5. elliptic/

183.01 #183. fruits <fruits enclosed within calyx at maturity>/
183.02 1. enclosed by calyx at maturity/
183.03 2. partly protruding from calyx at maturity <less than halfway>/
183.04 3. mostly protruding from calyx at maturity <more than halfway>/

184.01 #184. fruits <texture>/
184.02 1. papery/
184.03 2. cartilaginous/
184.04 3. woody/

185.01 #185. fruits <reticulation>/
185.02 1. visibly reticulate/
185.03 2. reticulation absent or obscured by hairs/

186.01 #186. fruiting calyces <orientation of mature calyx in fruit>/
186.02 1. erect/
186.03 2. patent <held horizontally>/

186.04 3. pendent/

187.01 #187. fruits <persistence of style as a beak on the fruit>/
187.02 1. style persistent on mature fruits/
187.03 2. style not persisting on mature fruits/

188.01 #188. fruits <beaked>/
188.02 1. beaked/
188.03 2. not beaked/

189.01 #189. fruits <spiny processes>/
189.02 1. spinulose/
189.03 2. not spinulose/

190.01 #190. fruits <vestiture of fruit>/
190.02 1. glabrous/
190.03 2. hairy/

191.01 #191. fruits <glandulosity of fruit>/
191.02 1. densely encrusted with glands/
191.03 2. sparsely glandular/

192.01 #192. seeds <length>/
192.02 mm long/

193.01 #193. seeds <width>/
193.02 mm wide/

194.01 #194. hilum <protrusion of hilum>/
194.02 1. protruding/
194.03 2. not protruding/

195.01 #195. hilum <position>/
195.02 1. central/
195.03 2. sub-terminal/

196.01 #196. seeds <mottling occurrence>/
196.02 1. mottled/
196.03 2. uniformly coloured/

197.01 #197. seed thickness/
197.02 mm/

198.01 #198. seeds <basic colour of seed>/
198.02 1. light brown/
198.03 2. chestnut brown/
198.04 3. khaki/
198.05 4. olive-green/
198.06 5. black/

199.01 #199. chromosome number/

200.01 #200. continental distribution/
200.02 1. North America/
200.03 2. South America/
200.04 3. Mediterranean Europe/
200.05 4. Canaries Islands/
200.06 5. North Africa and Arabia/
200.07 6. Indian sub-continent/

200.08 7. S.E. Asia/
200.09 8. Australasia/
200.10 9. Africa south of the Sahara/

201.01 #201. African distribution/
201.02 1. North Africa/
201.03 2. West Africa/
201.04 3. East Africa/
201.05 4. Angola/
201.06 5. Botswana/
201.07 6. Namibia - SWA/
201.08 7. Zimbabwe/
201.09 8. Transvaal/
201.10 9. Natal/
201.11 10. Swaziland/
201.13 11. Lesotho/
201.14 12. Cape Province/

202.01 #202. Flavonoid 1/
202.02 1. present/
202.03 2. absent/

203.01 #203. Flavonoid 2/
203.02 1. present/
203.03 2. absent/

204.01 #204. Flavonoid 3/
204.02 1. present/
204.03 2. absent/

205.01 #205. Flavonoid 4/
205.02 1. present/
205.03 2. absent/

206.01 #206. flavonoid 5/
206.02 1. present/
206.03 2. absent/

207.01 #207. flavonoid 6/
207.02 1. present/
207.03 2. absent/

208.01 #208. flavonoid 7/
208.02 1. present/
208.03 2. absent/

209.01 #209. flavonoid 8/
209.02 1. present/
209.03 2. absent/

210.01 #210. flavonoid 9/
210.02 1. present/
210.03 2. absent/

211.01 #211. flavonoid 10/
211.02 1. present/
211.03 2. absent/

212.01 #212. flavonoid 11/

212.02 1. present/
212.03 2. absent/

213.01 #213. flavonoid 12/
213.02 1. present/
213.03 2. absent/

214.01 #214. furanocoumarin a/
214.02 1. present as major component/
214.03 2. present/
214.04 3. absent/

215.01 #215. furanocoumarin b/
215.02 1. present as major component/
215.03 2. present/
215.04 3. absent/

216.01 #216. furanocoumarin c/
216.02 1. present as major component/
216.03 2. present/
216.04 3. absent/

217.01 #217. furanocoumarin d/
217.02 1. present as major component/
217.03 2. present/
217.04 3. absent/

218.01 #218. essential oil A/
218.02 1. present/
218.03 2. trace/
218.04 3. absent/

219.01 #219. essential oil B/
219.02 1. present/
219.03 2. trace/
219.04 3. absent/

220.01 #220. essential oil C/
220.02 1. present/
220.03 2. trace/
220.04 3. absent/

221.01 #221. essential oil D/
221.02 1. present/
221.03 2. trace/
221.04 3. absent/

222.01 #222. essential oil E/
222.02 1. present/
222.03 2. trace/
222.04 3. absent/

223.01 #223. essential oil F/
223.02 1. present/
223.03 2. trace/
223.04 3. absent/

224.01 #224. essential oil G/
224.02 1. present/

224.03 2. trace/
224.04 3. absent/

225.01 #225. stems branches <channelling>/
225.02 1. strongly channelled <furrowed>/
225.03 2. weakly channelled/
225.04 3. not channelled/

226.01 #226. stems <shape in transverse section>
226.02 1. flattened/
225.03 2. rounded/

APPENDIX 16

Descriptions of the Conservation status of African Psoraleeae.

APPENDIX 16

Conservation Status of African Psoraleeae

22-NOV-87

1. The genus *Otholobium*

O. acuminatum (Lam.) C.H. Stirton
Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire susceptible. Flowering period narrow.

O. accrescens C.H. Stirton
Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category nt. Rabinowitz code ARN. Seed production light. Fire resistant. Flowering period medium.

O. arborescens C.H. Stirton
Local population size: sparse. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category nt. Rabinowitz code SWN. Seed production heavy. Fire susceptible. Flowering period medium.

O. argenteum (Thunb.) C.H. Stirton
Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code AWN. Seed production light. Fire susceptible. Flowering period narrow.

O. bolusii (Forbes) C.H. Stirton
Local population size: sparse. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code SWN. Seed production light. Fire resistant. Flowering period medium.

O. bowieanum (Harv.) C.H. Stirton
Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code ARN. Seed production light. Fire resistant. Flowering period narrow.

O. bracteolatum (Eckl. & Zeyh.) C.H. Stirton
Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire susceptible. Flowering period wide.

O. caffrum (Eckl. & Zeyh.) C.H. Stirton
Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire resistant. Flowering period wide.

O. candicans (Eckl. & Zeyh.) C.H. Stirton

Local population size: sparse. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code SWW. Seed production light. Fire resistant. Flowering period medium.

O. carneum (E. Mey.) C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category E. Rabinowitz code SRN. Seed production light. Fire susceptible. Flowering period narrow.

O. dreweae C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category E. Rabinowitz code ARN. Seed production light. Fire resistant. Flowering period narrow.

O. flexuosum C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SRN. Seed production light. Fire susceptible. Flowering period narrow.

O. foliosum (Oliv.) C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire susceptible. Flowering period wide.

O. fruticans (L.) C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code ARN. Seed production light. Fire resistant. Flowering period narrow.

O. fumeum C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category nt. Rabinowitz code AWN. Seed production heavy. Fire susceptible. Flowering period wide.

O. gazense (Baker) C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire susceptible. Flowering period wide.

O. hamatum (Harv.) C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SRN. Seed production light. Fire susceptible. Flowering period narrow.

O. heterosepalum (Fourcade) C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SRN. Seed production light. Fire susceptible. Flowering period narrow.

O. hirtum (L.) C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire susceptible. Flowering period narrow.

O. incanum C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code SRN. Seed production light. Fire susceptible. Flowering period narrow.

O. lanceolatum C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category E. Rabinowitz code ARN. Seed production light. Fire resistant. Flowering period narrow.

O. lucens C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code ARN. Seed production light. Fire resistant. Flowering period medium.

O. macradenium (Harv.) C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code ARN. Seed production light. Fire resistant. Flowering period narrow.

O. mundianum (Eckl. & Zeyh.) C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category nt. Rabinowitz code AWN. Seed production heavy. Fire resistant. Flowering period narrow.

O. nigricans C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire susceptible. Flowering period wide.

O. nitens C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SRN. Seed production light. Fire resistant. Flowering period narrow.

O. obliquum (E. Mey.) C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category nt. Rabinowitz code ARN. Seed production light. Fire resistant. Flowering period narrow.

O. parviflorum (E. Mey.) C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code ARN. Seed production heavy. Fire resistant. Flowering period narrow.

O. pictum C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code ARN. Seed production light. Fire susceptible. Flowering period narrow.

O. piliferum C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code SRN. Seed production light. Fire resistant. Flowering period narrow.

O. polyphyllum (Eckl. & Zeyh.) C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SRN. Seed production light. Fire susceptible. Flowering period narrow.

O. polystictum (Benth. ex Harv.) C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire susceptible. Flowering period wide.

O. prodiens C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire susceptible. Flowering period wide.

O. pungens C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category E. Rabinowitz code SRN. Seed production light. Fire susceptible. Flowering period narrow.

O. pustulatum C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SRN. Seed production light. Fire susceptible. Flowering period narrow.

O. racemosum (Thunb.) C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code ARN. Seed production light. Fire resistant. Flowering period narrow.

O. rotundifolium (L.f) C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code AWN. Seed production light. Fire resistant. Flowering period narrow.

O. rubicundum C.H. Stirton

Local population size: sparse. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code SWN. Seed production light. Fire susceptible. Flowering period narrow.

O. sabulosum C.H. Stirton

Local population size: sparse. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code SWN. Seed production light. Fire susceptible. Flowering period narrow.

O. saxosum C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category E. Rabinowitz code ARN. Seed production light. Fire resistant. Flowering period narrow.

O. sericeum (Poir.) C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire susceptible. Flowering period wide.

O. spicatum (L.) C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category nt. Rabinowitz code AWN. Seed production heavy. Fire susceptible. Flowering period medium.

O. spissum C.H. Stirton

Local population size: sparse. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SWN. Seed production light. Fire susceptible. Flowering period narrow.

O. stachyerum (Eckl. & Zeyh.) C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire susceptible. Flowering period wide.

O. striatum (Thunb.) C.H. Stirton

Local population size: sparse. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code SWW. Seed production light. Fire susceptible. Flowering period wide.

O. swartbergense C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code ARN. Seed production light. Fire resistant. Flowering period narrow.

O. thomii (Harv.) C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code ARN. Seed production light. Fire resistant. Flowering period narrow.

O. trianthum (E. Mey) C.H. Stirton

Local population size: sparse. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code SWW. Seed production light. Fire susceptible. Flowering period narrow.

O. uncinatum (Eckl. & Zeyh.) C.H. Stirton

Local population size: sparse. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code SWW. Seed production light. Fire susceptible. Flowering period narrow.

O. venustum (Eckl. & Zeyh) C.H. Stirton

Local population size: sparse. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category V. Rabinowitz code SWW. Seed production light. Fire susceptible. Flowering period narrow.

O. virgatum (Burm. f.) C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire resistant. Flowering period wide.

O. wilmsii (Harms) C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production light. Fire susceptible. Flowering period wide.

O. zeyheri (Harv.) C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code AWN. Seed production light. Fire resistant. Flowering period medium.

The genus *Psoralea*

P. abbottii C.H. Stirton

Local population size: sparse. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SWN. Seed production light. Fire susceptibility unknown. Flowering period unknown.

P. aculeata L.

Local population size: sparse. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SWN. Seed production unknown. Fire susceptibility unknown. Flowering period unknown.

P. affinis Eckl. & Zeyh.

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire susceptibility unknown. Flowering period unknown.

P. alata (Thunb.) Salter

Local population size: sparse. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category nt. Rabinowitz code SWN. Seed production light. Fire susceptible. Flowering period unknown.

P. aphylla L.

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category nt. Rabinowitz code AWN. Seed production light. Fire susceptible. Flowering period unknown.

P. arborea Sims

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category V. Rabinowitz code AWW. Seed production heavy. Fire susceptible. Flowering period unknown.

P. asarina (Berg.) Salter

Local population size: sparse. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category nt. Rabinowitz code SWN. Seed production light. Fire resistant. Flowering period unknown.

P. axillaris L.f.

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production unknown. Fire susceptibility unknown. Flowering period unknown.

P. azurea C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SRN. Seed production light. Fire resistant. Flowering period narrow.

P. cataracta C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category Ex. Rabinowitz code SRN. Seed production light. Fire susceptibility unknown. Flowering period narrow.

P. crista C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SRN. Seed production light. Fire susceptibility unknown. Flowering period unknown.

P. elegans C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SRN. Seed production heavy. Fire susceptibility unknown. Flowering period narrow.

P. ensifolia (Houtt.) Merrill

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code AWN. Seed production heavy. Fire resistant. Flowering period unknown.

P. fascicularis DC.

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category K. Rabinowitz code ARN. Seed production light. Fire resistant. Flowering period unknown.

P. filifolia Eckl. & Zeyh.

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category E. Rabinowitz code AWN. Seed production unknown. Fire susceptibility unknown. Flowering period unknown.

P. fleta C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code ARN. Seed production heavy. Fire susceptible. Flowering period unknown.

P. glabra E. Mey.

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire susceptibility unknown. Flowering period unknown.

P. glaucescens Eckl. & Zeyh.

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code AWN. Seed production light. Fire susceptibility unknown. Flowering period narrow.

P. glaucina Harv.

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category E. Rabinowitz code SRN. Seed production light. Fire susceptibility unknown. Flowering period narrow.

P. gueinzii Harv.

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category Ex. Rabinowitz code ARN. Seed production heavy. Fire susceptible. Flowering period narrow.

P. imbricata (L.f.) Salter

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code AWN. Seed production light. Fire resistant. Flowering period unknown.

P. imminens C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code ARN. Seed production heavy. Fire susceptibility unknown. Flowering period narrow.

P. implexa C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SRN. Seed production light. Fire resistant. Flowering period narrow.

P. intonsa C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code ARN. Seed production unknown. Fire susceptibility unknown. Flowering period unknown.

P. keetii Schonl. ex H.M.L. Forbes

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SRN. Seed production unknown. Fire susceptibility unknown. Flowering period unknown.

P. laevigata L.f.

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SRN. Seed production unknown. Fire susceptibility unknown. Flowering period unknown.

P. laxa Salter

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production light. Fire resistant. Flowering period unknown.

P. monophylla (L.) C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production light. Fire resistant. Flowering period unknown.

P. muirii C.H. Stirton

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category E. Rabinowitz code SRN. Seed production unknown. Fire susceptibility unknown. Flowering period narrow.

P. nubicola C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code ARN. Seed production heavy. Fire susceptibility unknown. Flowering period narrow.

P. odoratissima Jacq.

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SRN. Seed production unknown. Fire susceptibility unknown. Flowering period unknown.

P. oligophylla Eckl. & Zeyh.

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire susceptible. Flowering period unknown.

P. oreophila Schlechter

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SRN. Seed production light. Fire resistant. Flowering period unknown.

P. oreopola C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code AWN. Seed production unknown. Fire resistant. Flowering period narrow.

P. peratica C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code ARN. Seed production unknown. Fire susceptibility unknown. Flowering period unknown.

P. pinnata L.

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production heavy. Fire susceptible. Flowering period unknown.

P. plauta C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production light. Fire resistant. Flowering period unknown.

P. pullata C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code AWN. Seed production heavy. Fire susceptible. Flowering period unknown.

P. repens Berg.

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code AWN. Seed production light. Fire susceptibility unknown. Flowering period narrow.

P. restioides Eckl. & Zeyh.

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code AWN. Seed production heavy. Fire resistant. Flowering period unknown.

P. rhizotoma C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category nt. Rabinowitz code AWN. Seed production unknown. Fire resistant. Flowering period unknown.

P. rigidula C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category V. Rabinowitz code ARN. Seed production light. Fire resistant. Flowering period unknown.

P. sordida C.H. Stirton

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category nt. Rabinowitz code AWN. Seed production light. Fire resistant. Flowering period unknown.

P. speciosa Eckl. & Zeyh.

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category nt. Rabinowitz code AWN. Seed production light. Fire susceptibility unknown. Flowering period unknown.

P. tenuissima E. Mey.

Local population size: sparse. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category nt. Rabinowitz code SWN. Seed production light. Fire resistant. Flowering period unknown.

P. triflora Thunb.

Local population size: sparse. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SWN. Seed production light. Fire susceptibility unknown. Flowering period unknown.

P. trullata C.H. Stirton

Local population size: sparse. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code SWN. Seed production light. Fire resistant. Flowering period unknown.

P. verrucosa Willd.

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production unknown. Fire susceptibility unknown. Flowering period unknown.

P. vlokii C.H. Stirton

Local population size: abundant. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category R. Rabinowitz code ARN. Seed production unknown. Fire resistant. Flowering period narrow.

The genus *Cullen*

C. biflora Harv.

Local population size: abundant. Geographic range: widespread. Habitat specificity: narrow. IUCN conservation category K. Rabinowitz code AWN. Seed production unknown. Fire susceptibility unknown. Flowering period unknown.

C. holubii Burtt Davy

Local population size: sparse. Geographic range: restricted. Habitat specificity: narrow. IUCN conservation category E. Rabinowitz code SRN. Seed production light. Fire susceptibility unknown. Flowering period unknown.

C. obtusifolia DC.

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production unknown. Fire susceptibility unknown. Flowering period unknown.

C. plicata Delile

Local population size: abundant. Geographic range: widespread. Habitat specificity: wide. IUCN conservation category nt. Rabinowitz code AWW. Seed production unknown. Fire susceptibility unknown. Flowering period unknown.

APPENDIX 17

Stirton, C.H. 1981d. Petal sculpturing in Papilionoid Legumes. In R.M. Polhill and P.H. Raven (Editors), *Advances in Legumes Systematics, Part 2.* pp. 771-788. Royal Botanic Gardens, Kew.

Advances in Legume Systematics, ed. R.M. Polhill & P.H. Raven, 1981

Petal Sculpturing in Papilionoid Legumes

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I. Introduction

The pea flower has a favoured place in biology textbooks, probably because it seems so suitably adapted to pollination by bees. Indeed the positioning and movement of a bee's body and feet as it lands on a papilionoid flower does suggest that this commonly recognised 'close-fit' relationship is functionally based. But what is the evidence? How can we account for bird and bat flowers and how has all this great variation come about?

It is well documented that there are several distinct pollination mechanisms in the Papilionoideae (Darwin, 1858; Knuth, 1908; Faegri & van der Pijl, 1979; Leppik, 1966; Kalin Arroyo, this volume). These mechanisms arise from differences among flowers as to their size, shape, colour, number, arrangement, and in their ability to secrete nectar, produce scent and to present pollen. Perhaps the 'typical' mechanisms (pump, brush, explosive etc.) are neither so typical nor so simple as they are mostly made out to be? Perhaps we ought to reconsider the evolutionary success of the papilionoid flower anew, not from some typological base but from an ecological perspective.

The floral biology of the Papilionoideae is a vast and relatively unstudied subject. It is perhaps understandable that in the absence of a suitable model of floral evolution most of our existing knowledge has emerged from basically temperate studies of agricultural legumes (Free, 1970) and of legumes cultivated in botanical gardens. This knowledge gave rise to concepts of which some are now in serious conflict with data emerging from recent field studies in the tropics and in mediterranean regions. The new biology is more broadly based and being essentially synthetic it is rapidly reinterpreting nineteenth century paradigms many of which still survive unchanged and unchallenged.

Evidence is accumulating to suggest that flowers of the Papilionoideae are evolutionarily successful because they have had the capacity to radiate into different lines of evolution each of which shows increasing specialisations in structure and function linked not only to different types of pollinators but also to different breeding systems. The emergence of such diversity must have required numerous functional-structural compromises within and between the component parts of the flower. This is significant for by searching for the constraints which characterise a particular reproductive unit we should then be able to establish criteria by which to compare other units; both for shufflings among the constraints themselves and for shifts to new or additional constraints. This should give us new insights into real biological characters. For example, flower colour is commonly viewed as a purely visual character, measurable as a variation of one to seven spectral noda. From a constraints approach, however, colour is a functional-structural character, a biological character, comprising a number of interacting elements such as surface micromorphology, internal anatomy and pigment chemistry

(Kay, Daoud & Stirton, 1981). The elements considered collectively thus constitute the character colour. Another example concerns how we view the flower itself. Is it merely an attractive display to encourage visitation by certain pollinating vectors while at the same time in some cases discouraging unwanted insect visitors (Faegri & van der Pijl, 1979)? In constraints terms the flower would have to be more. It would be the evolutionary compromise that best satisfies a number of evolutionary pressures, for example, the need to repel mammalian and other herbivores; attract suitable pollinators; ward off, discourage or confuse unwanted opportunists or robbers; to provide adequate protection to the developing ovules; to protect the developing seeds; to provide a platform for dispersal and so on. Some or all of these requirements are satisfied in any one type of flower and can be achieved in more than one way whether temporally, spatially or behaviourally. Seen in this way the flower becomes a more meaningful entity for anthecological studies - simply because it is seen as a continuing series of developmental constraint shuffles. Different taxa will of course differ in their basic set of constraints as well as the combination and types of adaptive shuffles that the constraints undergo over developmental time. A constraints approach therefore has inherently certain advantages (see Introduction) and so would enable one to investigate questions of convergence, parallel evolution and homology with greater confidence.

Clearly there is a need for a resynthesis of our knowledge about the reproductive biology of legumes, not only to improve classifications but also to clarify plant-plant as well as plant-pollinator relationships. This paper is a preliminary investigation of just one aspect of this resynthesis; the relationship between wing petals (landing stages) and flower visitors. This said it must be reiterated that the wing petal is not merely an isolated character but is rather an essential component of a higher order functional-structural whole. Its evolutionary development should therefore reflect something of the evolutionary development of the flower as a whole.

II. Materials and Methods

The micromorphology of wing petals of all genera of the Papilionoideae, represented by 1156 species, has been studied using light, polarising and scanning-electron microscopy.

Dried wing petals were taken from herbarium specimens of 40 species, mounted on stubs, coated with platinum in a Balzer splutter coater and then examined with a JEOL JSM-T20 SEM (at 15 KV). The adaxial and abaxial surfaces of a further 1116 species were examined using a zoom binocular microscope. The anatomy and surface morphology of 50 species were also studied in the fresh state and compared with herbarium material.

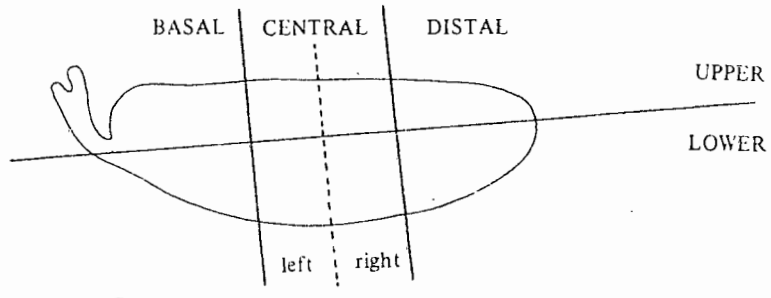
Voucher specimens are housed in the Royal Botanic Gardens, Kew (K), and a list of the vouchers studied is also deposited at the Botanical Research Institute, Pretoria, South Africa (PRE).

III. Wing Petals and Flower Visitors

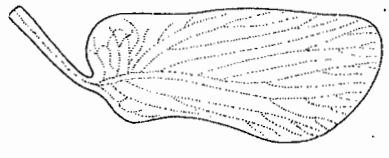
Wing petals serve a threefold function. They serve as attractants, as a landing

e.g. ASPALATHUS LANIFERA
Sculpture present, exposed, pocket absent, upper basal with 3 rows of inclined lunate folds each composed of 8–14 lunae, crest cells papillate and striate, trough cells flat and smooth

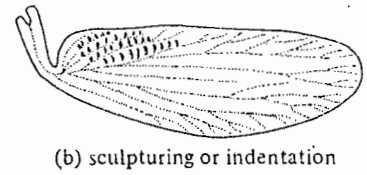
1 POSITION



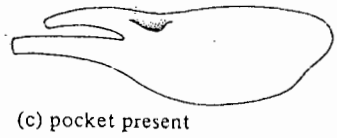
2 POCKETING



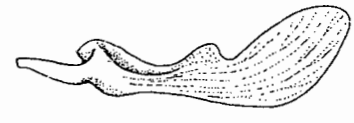
(a) pocket absent



(b) sculpturing or indentation

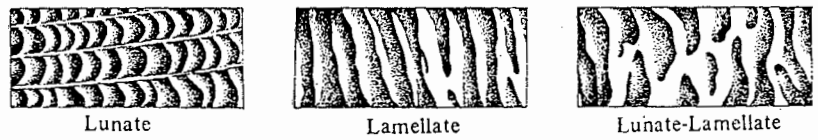


(c) pocket present



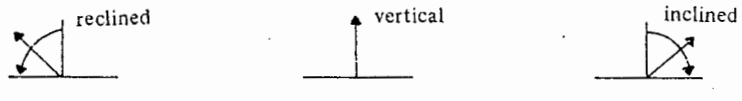
(d) folded upper margin

3 TYPES OF SCULPTURING



Lunate Lamellate Lunate-Lamellate

4 ORIENTATION OF ROWS



5 EXPOSURE OF SCULPTURING

Fig. 1 Terminology used to describe wing petal sculpturing

stage for bees and as levers to depress and raise the keel (Knuth, 1908). Several authors have reported on the existence of rows of wrinkles, lunae, rugae and lamellae on the outer surfaces of wing petals in a number of genera. Schlieden & Vogel (1839) were the first workers to draw attention to this phenomenon which they termed *alae foveolata-rugosae*. They reported its occurrence in a wide number of genera in the Papilionoideae and noted its absence in Caesalpinioideae and Mimosoideae. Several authors rediscovered this phenomenon some 120 years later but still did not comment on any possible function (Dahlgren, 1963; Polhill, 1976; Narang 1977). The function of these epidermal foldings and the extent of their occurrence in different tribes is still undetermined. However because Dahlgren (1963) has shown that in *Aspalathus* the number and arrangement of the small transverse folds is usually more or less characteristic of species it seemed worthwhile investigating the phenomenon on a wider scale. This however posed a problem as there is no terminology available which facilitates an easy reference to the different structures, regions and types of sculpturing that occur in wing petals.

The basic terminology that I will adopt in this paper is illustrated in Fig. 1. The five major characters that will be used are the position, type and orientation of the epidermal foldings or sculpturing, whether they are hidden by other structures (e.g. the standard) or not, and finally whether a pocket is present or absent. The species depicted in Fig. 1 is *Aspalathus lanifera*. Its sculpturing, using this terminology, may be described as : 'present, exposed, pocket absent, upper basal with three rows of inclined lunate folds each composed of 8–14 lunae, crest cells papillate and striate, trough cells flat and smooth'.

IV. Results and Discussion

The surface micromorphology of petals is not the smooth surface as seen by the human eye but approximates 'science-fiction like' landscapes of remarkable patterns and structures. SEM studies of petal surfaces have revealed striking differences among different families of angiosperms (Polemoniaceae, Asteraceae, Orchidaceae, Ranunculaceae, Labiatae, Commelinaceae – Stirton unpublished data; Kay, Daoud & Stirton, 1981, for survey) and this is reflected also within members of the Leguminosae which show specific, generic and tribal variations.

A. Specific and generic variation

If one traversed the adaxial surface of a wing petal with an SEM one would view an everchanging landscape. This is shown for *Podocytisus caramanicus* in Fig. 2, which depicts three major surface patterns that gradually merge into each other.

The most prominent feature in Fig. 2 is the 'stairway' or sculpturing situated in the upper basal region of the petal (Fig. 2.9). In this region the epidermis is folded strongly into distinct troughs and ridges (Fig. 2.6), each of which has a distinctive cell surface pattern. The cells comprising the ridges (Fig. 2.8) are smaller, more papillate and more densely covered with striae

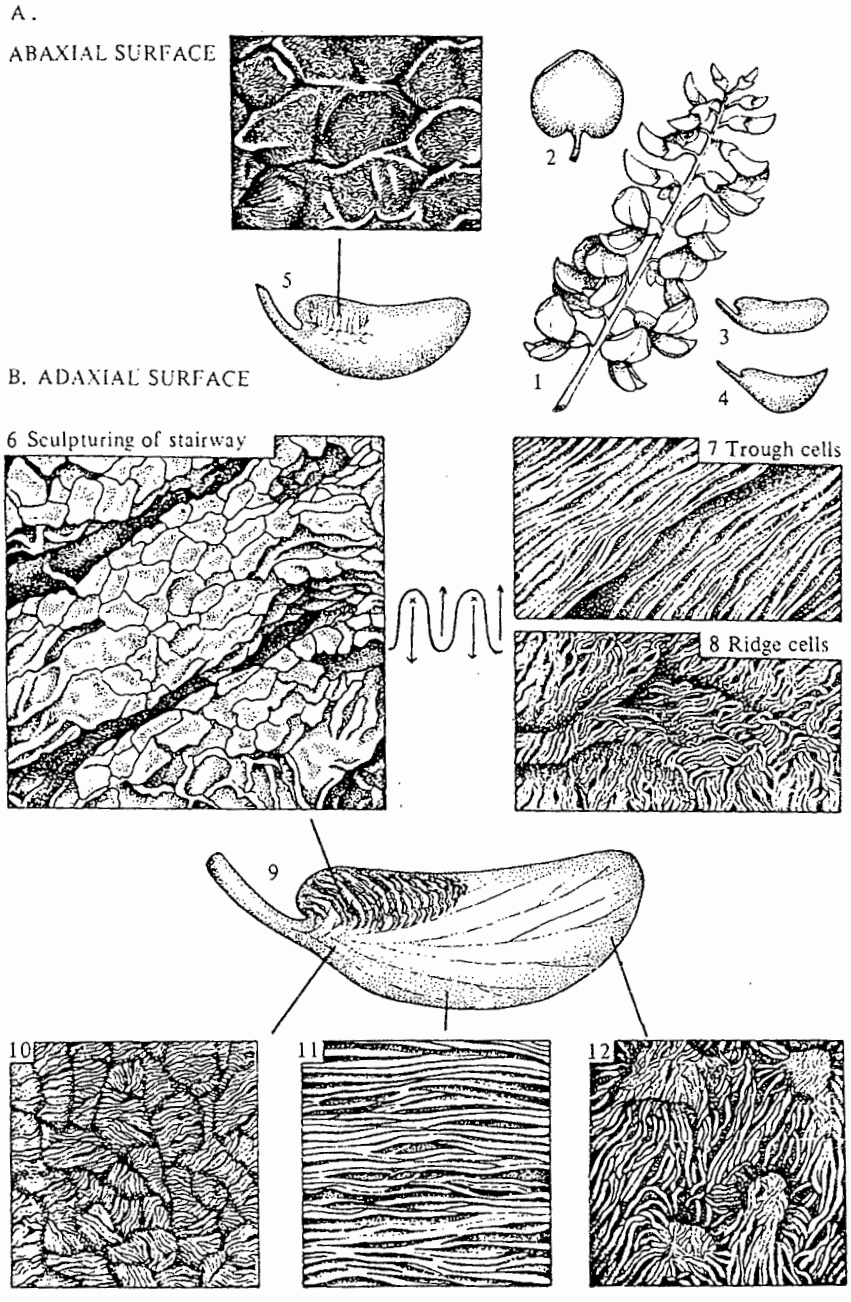


Fig. 2 Surface patterns on wing petal of *Podocytisus caramanicus*. 1 Inflorescence with 2 standard, 3 wing petal, 4 keel petal; A – abaxial surfaces of wing petal; 5 cell surface pattern lying beneath the sculptured area of the adaxial surface; B – adaxial surfaces of wing petal with 6 sculpturing of stairway (×145) showing troughs and ridges, 7 cell surfaces of trough cells (×1000), 8 cell surfaces of ridge cells, 9 adaxial surface of petal, 10 intercostal cell surfaces over lower half of the petal, 11 basal intercostal cell pattern, 12 intercostal cell pattern confined to distal edges and tip area of the petal

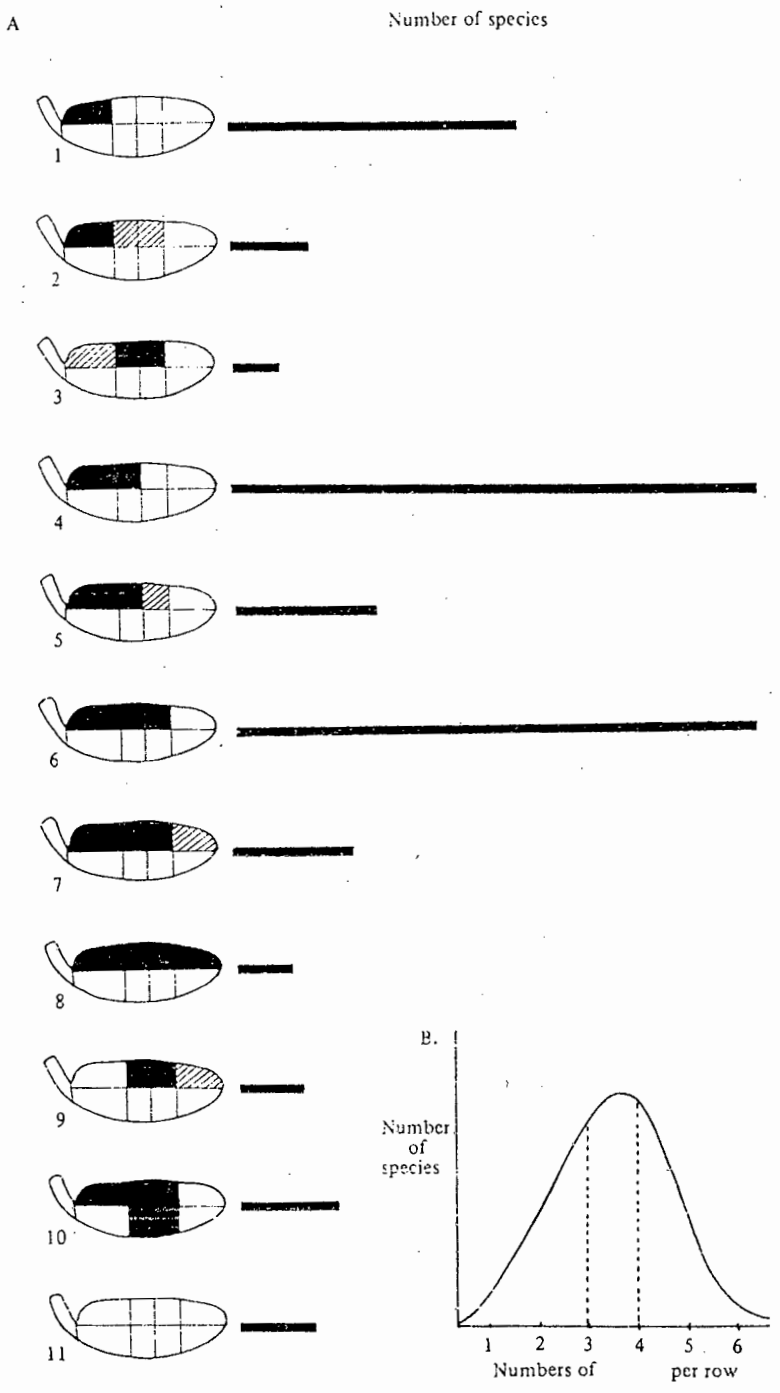


Fig. 3 Localisation of sculpturing on wing petals of 215 species of *Aspalathus* in Southern Africa. A – sculpturing occurs in eleven zones (1–11); groups 1, 4 and 6 represent the majority of species. B – the graph indicates the number of lunae that make up each row and is representative of the genus as a whole; the majority of species have 3–4 lunae per row. Shading means that sculpturing fades rapidly as it enters that particular zone.

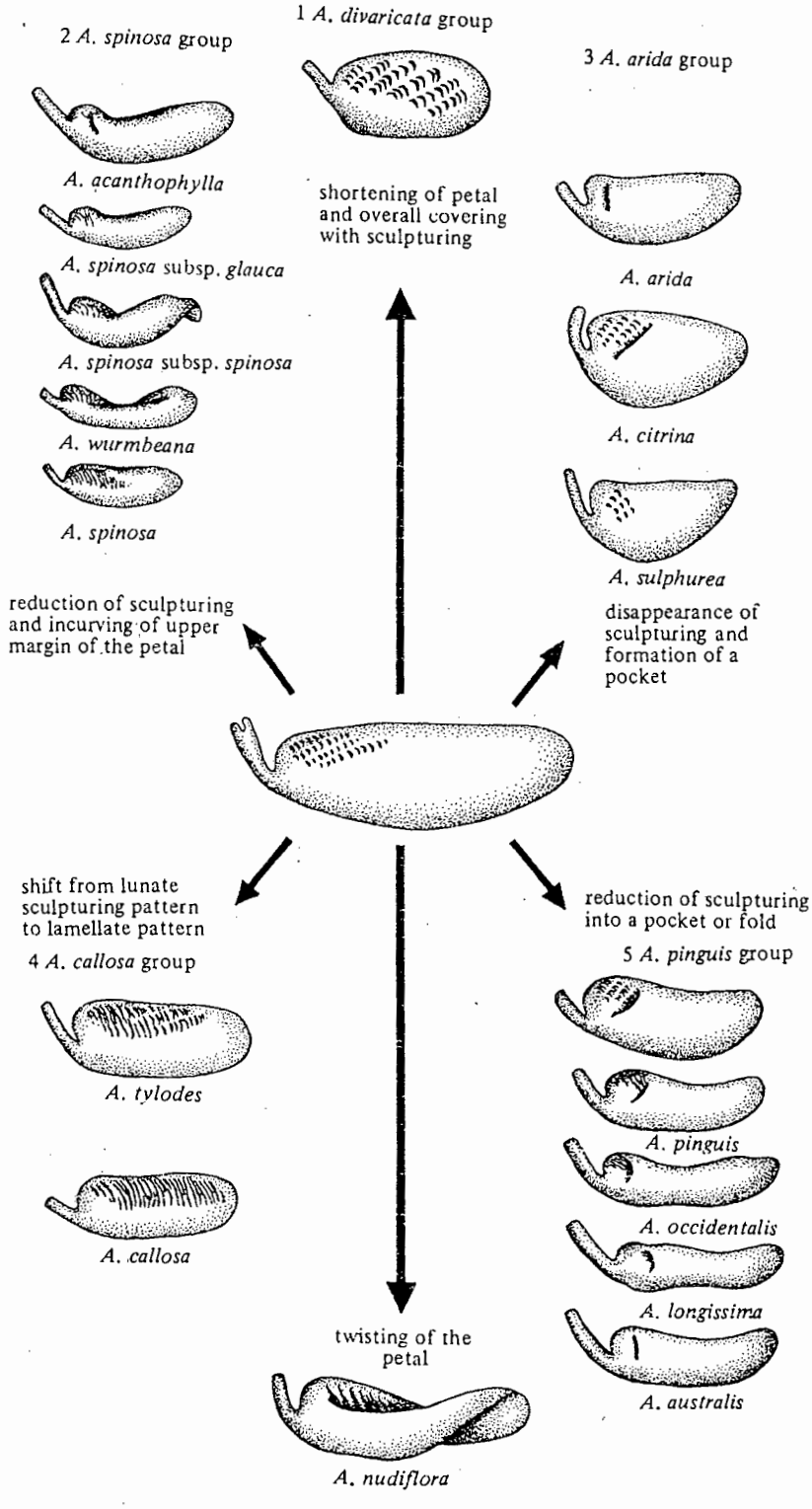


Fig. 4 Trends in wing-petal sculpturing in *Aspalathus*

than are the cells lining the troughs (Fig. 2.7). Towards the lower basal and left central regions of the petal the surface pattern changes from the basic pattern (Fig. 2.10) into a pattern (Fig. 2.11) somewhat similar to that found in the trough area of the ridges (Fig. 2.7). Raised papillate cells (Fig. 2.12) are confined mostly along edges and distally. The epidermal epithelium is continuous throughout the surface of the petal. There is a marked difference however between the surface patterns of the adaxial and abaxial surfaces of the petal. In contrast to the sculptured adaxial surface the abaxial surface has an almost uniform cell pattern (Fig. 2.5) and so will not be discussed further. The shape and size of the epidermal cells of both surfaces also differs. Similar trends have been reported by Smettanikova (1961) in *Medicago*, by Dahlgren (1963) in *Aspalathus* and by Borzos (1975) in *Lotus*. The significance of these differences will be discussed in section IV.B.1.

The sculpturing of the wing petal of *P. caramanicus* (Fig. 2) can be described as : present, covered, situated upper basal and left central occasionally lower basal, with numerous long crescentiform lamellae, pocket absent, crest cells papillate and striate, trough cells flattish and slightly striate. This description differs considerably to that described earlier for *Aspalathus lanifera*. However, before such intergeneric differences can be discussed it is important to establish first whether sculpturing is a constant feature within individuals of a species and between species of the same genus.

The genus *Aspalathus* , with 267 species, is mostly restricted to the Cape fynbos area (Mediterranean macchia) of South Africa. A few outliers extend into Natal and the Transkei. An analysis of the wing sculpturing in 215 species is shown in Fig. 3. Sculpturing occurs in all species except *A. fasciculata, A. dunsdoniana* and *A. patens*. Twelve different patterns of sculpturing are recognised (Fig. 3). Sculpturing is found predominantly in the upper half of the adaxial surface of the wings, occupying mainly the basal and central regions. Two main types of folding occur in *Aspalathus*: lunate and lamellate. Transitions from one type to another can occur in the same petal but these are less common. There are most commonly 3–4 rows of lunate or lamellate folds, with several to many lunae or lamellae in each row. It is significant that the different types of sculpturing patterns found are nearly always correlated not only to the shape of the other petals but also to other features, for example, laxness or compactness of inflorescences. In Fig. 4 one can see some of the trends that occur in *Aspalathus*. In my experience there is a general trend towards a reduction in sculpturing as flowers become more specialised.

A. spinosa (Fig. 4.2) is a good example of a species that exhibits a considerable variation of petal sculpturing, especially of plants growing in different geographical areas. In this species there is an increasing rigidity of the petals. This is correlated with a decrease in the number of epidermal foldings and an increased inwards curving of the upper margin of the wings (Dahlgren, pers. comm.)

The genus *Wiborgia* is a small genus endemic to the Cape Province in South Africa. (Dahlgren, 1975). Sculpturing is present in all ten species (nine illustrated in Fig. 5) and may be weakly (*W. tetraptera*) or strongly developed (*W. monoptera*). All species of *Wiborgia* except *W. humilis* have a lunate sculpturing. In the latter species the lunae shift to reclined lamellae-

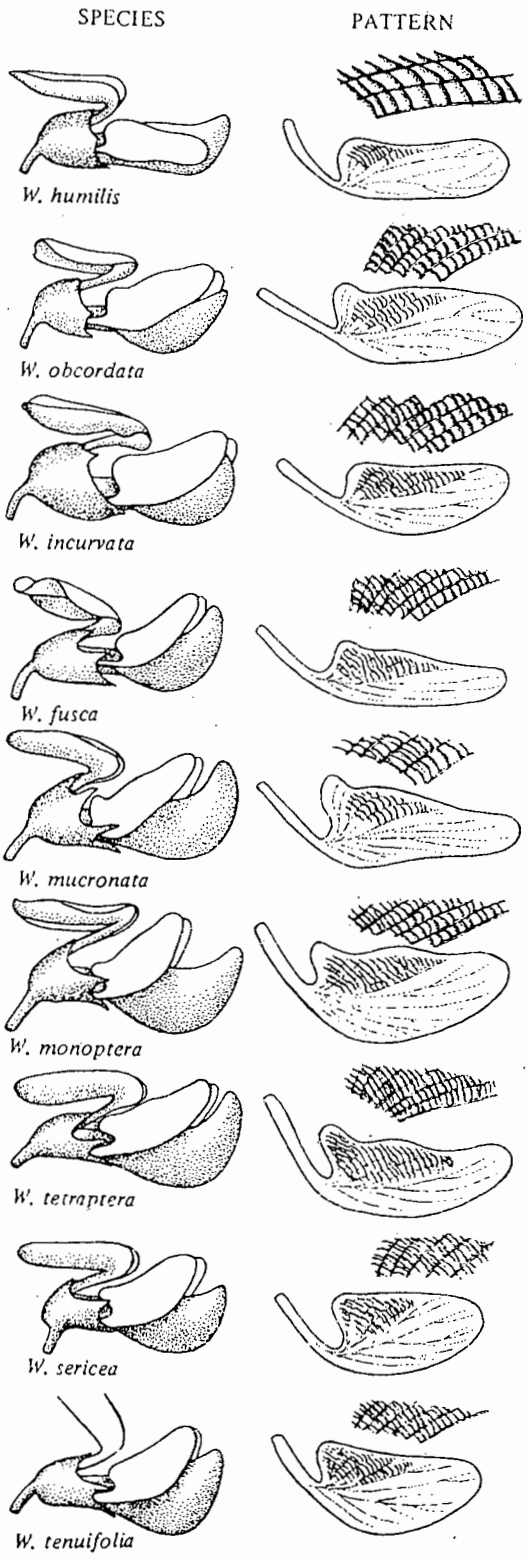


Fig. 5 Patterns of wing-petal sculpturing in *Wiborgia*, an endemic Cape genus.

like rows restricted to the upper basal and upper left central regions.

This survey of wing petals in *Wiborgia* and *Aspalathus* shows that sculpturing is generally constant for a species and that its degree of development is correlated with other features of the flower. Furthermore it is for the majority of species constant within a species although in a few species it exhibits certain geographically linked variations. It remains to determine how many other papilionoid genera have sculpturing and whether there are more patterns than those discussed already.

B. Tribal variation

A survey of 377 genera (1156 species) showed that the presence of wing sculpturing is a prominent feature of the Papilionoideae (Fig. 6). It occurs consistently in 9 tribes and 190 genera and is absent in 9 tribes and 167 genera but in 13 tribes there are genera with and without sculpturing (Fig. 6.1–2). In 20 genera there were species both with and without wing sculpturing. If compared on a species basis there were 920 species with sculpturing and 236 species without sculpturing (Fig. 6.3).

The presence and absence of sculpturing among different tribes of the Papilionoideae is given in Figs 6.1 and 7. There seems to be a correlation between geographical distribution and sculpturing. Tribes characterised by wing sculpturing are the Aeschynomeneae, Adesmieae, Mirbelieae, Dipteryxeae, Bossiaeeae, Crotalarieae, Sesbanieae, Euchresteae and Genisteae. It is absent in the Carmichaelieae, Psoraleeae, Abreae, Amorpheae, Indigofereae, Hedysareae, Trifolieae, Cicereae, and Loteae. The remaining tribes can be divided into : (1) those which can be divided into two groups on the basis of different genera being characterised by either a presence or an absence of sculpturing (e.g. Brongniartieae, Robinieae, Psoraleeae, Desmodieae, Phaseoleae, Vicieae, Podalyrieae, Liparieae, Thermopsideae, Coronilleae, Sophoreae, Dalbergieae, Tephrosieae); or (2) into those in which certain genera are characterised by also having species both with and without sculpturing (e.g. Galegeae – *Clianthus, Swainsona, Chesneya*).

It will be important in interpreting these results to be aware that an absence of petal sculpturing, as for its presence, may have evolved independently and at different periods during the evolution of the Papilionoideae. This is supported both by the trends already reported for *Aspalathus*, where it was shown that absence was a late development in the genus, and by the different types of petal modifications that may have occurred either as a development through a sculpturing series (Fig. 10) or independently. Petals which lack sculpturing can be divided into a number of groups : (1), with pockets (e.g. *Astragalus alopecuroides*); (2), without pockets (e.g. *Robinia pseudoacacia*); (3), with thickening and puckering of the upper margin (e.g. *Canavalia virosa*); and (4), with thickening and a deep depression in the area of the auricle (e.g. *Cyclopia aurescens*). In a number of species sculpturing is absent on the blade but occurs along the claws (e.g. *Pickeringia montana, Virgilia oroboides*). Occasionally when the wings are very reduced in relation to the keel petals the later are sculptured, for example, in *Ebenus stellatus*.

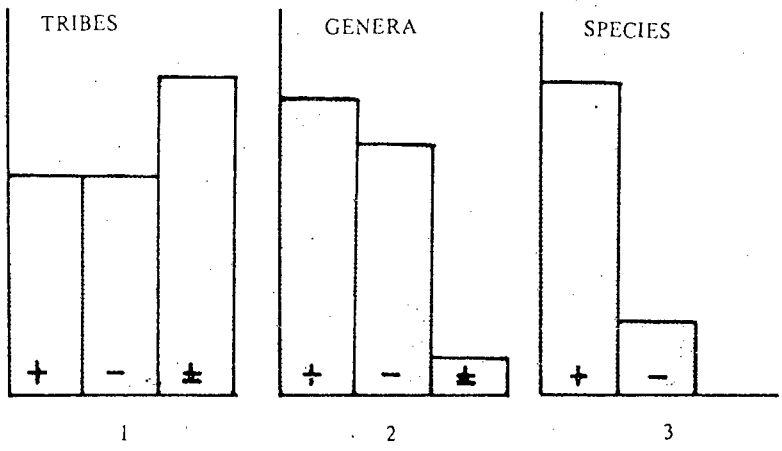


Fig. 6 Occurrence of wing-petal sculpturing in papilionoid legumes. 1 tribal distribution; 2 generic distribution; 3 specific distribution (+ indicates present of sculpturing, − indicates absence of sculpturing and ± presence and absence of sculpturing).

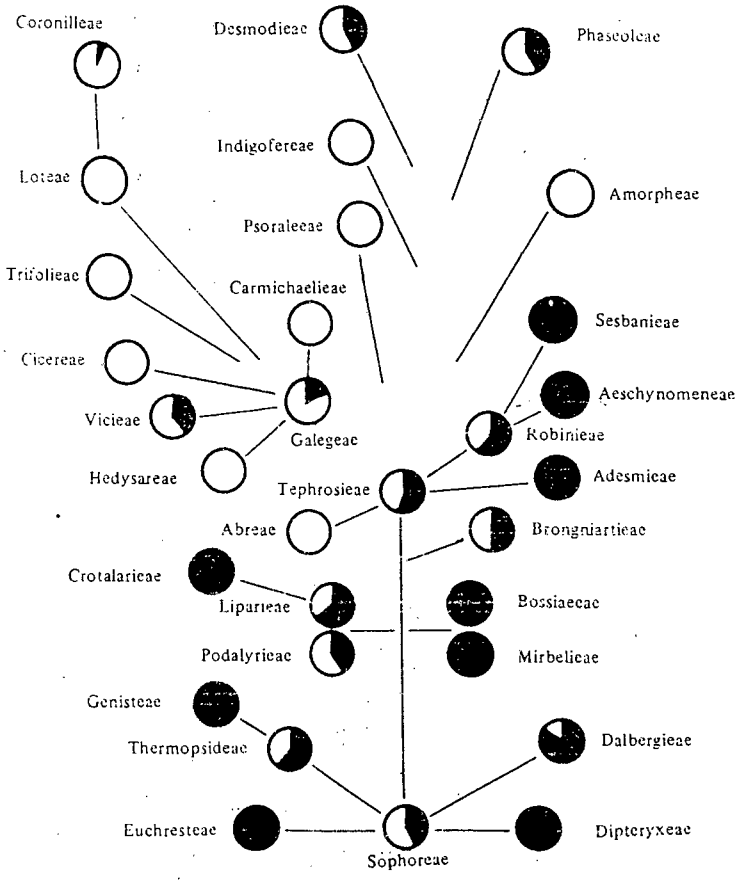


Fig. 7 Occurrence of petal sculpturing in 31 tribes of Papilionoideae. • indicates sculpturing is present in all genera, o sculpturing absent in all genera, ⊖ proportional occurrence and absence of sculpturing among genera in the tribe.

1. Localisation of sculpturing

The region of the wing petal covered by sculpturing is fairly uniform among genera. A detailed survey and analysis of 581 species from 170 genera established that sculpturing occurs most commonly in the upper basal and upper central regions (Fig. 8). Sculpturing covering the entire outer surface occurred in only seven species (*Amicia zygomeris, Aspalathus lenticulata, Centrolobium tomentosum, Dussia foxii, D. tessmanii, Luetzelbergia auriculata, Steinbachiella carthagensis*). The consistent localisation of petal sculpturing in a small area of the wing petal is parallelled in taxa which lack sculpturing by the occurrence of shallow depressions, puckerings or pockets. Evidence which suggests that the latter structures serve a similar purpose to that of sculpturing; that of footholds or thrusting pads for visiting insects.

2. Types of sculpturing

As can be seen in Fig. 9 there are many different types of sculptural patterns in the Papilionoideae. It is still too early to discuss the distribution of these patterns among tribes except in a few cases where the patterns have been studied in some detail, for example, the Aeschynomeneae and Crotalarieae.

Lunate sculpturing is almost restricted to the tribes Crotalarieae (except *Bolusia* and *Sellocharis*), Aeschynomeneae (except *Pachecoa, Chapmannia, Geissaspis,* and *Brya*), the genera *Lupinus, Argyrolobium* and *Stauracanthus* (Genisteae), and *Tipuana* (Dalbergieae).

The finely lamellate sculpturing of the Bossiaeeae and the Mirbelieae (Australian Podalyrieae) is also very distinctive and strengthens the suggestion that they should be separated from the South African Podalyrieae.

Evolutionary trends are apparent in certain tribes. For example in the Genisteae there is a gradual shift (Fig. 10) from genera with typical lunate sculpturing (*Lupinus*) through coalescing lunae (*Argyrolobium*) into lamellate ridging (*Cytisus*) and finally pockets (*Gonocytisus*). This scheme is speculative as both *Lupinus* and *Argyrolobium*, being peripheral to the Genisteae as a whole may be uncomfortably placed in the Genisteae. In which case an alternative explanation would have to be looked for to explain their present position.

C. Taxonomic usefulness

The monotypic genus *Walpersia* was described to place an unusual species of the 'South African' Podalyrieae. This species, known from the type specimen only, had puzzled botanists for many years. Dahlgren (1965) recently drew attention to its similarity to *Burtonia*, a genus in the Mirbelieae (Australian Podalyrieae). His conclusion that *Walpersia burtonoides* is a synonym of *Burtonia phylicoides* is supported by the similarity in their wing sculpturing. *W. burtonoides* has the typical fine lamellate epidermal foldings of the Mirbelieae and is quite different to sculpturing patterns found in South African Podalyrieae. The occurrence of *Walpersia burtonoides* in South Africa is probably best explained by the introduction of *Burtonia* as a garden plant. Of real interest however is that Bentham's tribe Podalyrieae contains two

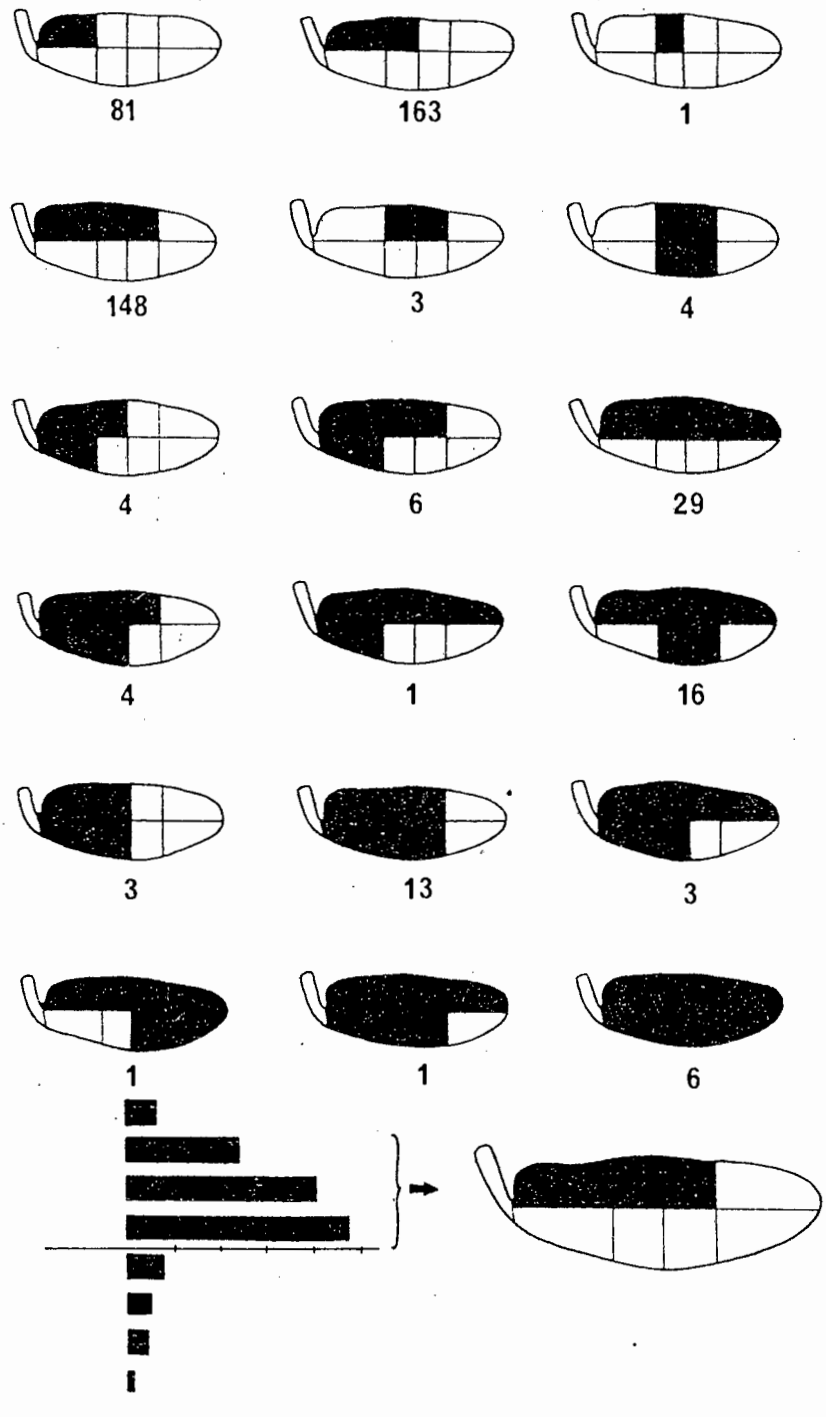


Fig. 8 Analysis of position of sculpturing in 581 species of 170 genera of Papilionoideae. 68% of the species have a localised sculpturing that occurs in the upper basal and upper central region of the wing petal. This is shown in the accompanying bar graph. Numbers indicate number of species with the particular zonation.

major types of wing sculpturing. This datum supports Polhill's conclusion (this volume) that the 'Australian Podalyrieae' are a separate tribe, the Mirbelieae.

Brya, Pachechoa, Chapmannia and *Geissaspis* in the Aeschynomeneae do not have the typical lunate sculpturing of the remaining genera in the tribe. *Brya* is better placed elsewhere, perhaps in Desmodieae. Too little is known about wing sculpturing in other important tribes such as Sophoreae, Dalbergieae and the Tephrosieae to be able to account for other anomalies. One has to remember that the possibility exists, as was shown in *Aspalathus*, that an absence of sculpturing may merely be the result of reduction in a developmental series. In such a case the species and genera may be correctly placed. Clarity between ecological convergence and genetic affinity is obviously very important and is a problem which must be faced in a study such as this one.

The real taxonomic value of petal sculpturing is yet to be assessed but as it becomes recognised as a potentially useful character it may prove to be a valuable biological marker in related disciplines (see note at end).

V. Conclusions

Sculpturings on the outer surface of wing petals are a widespread feature of the Papilionoideae. These epidermal foldings serve predominantly as footholds for insect pollinators. In species which lack sculpturings it is the entire petal that has become convoluted or pocketed rather than just the outer epidermis. In these cases the pockets serve as thrusting pads for forcible entry by pollinating insects. (Stirton, 1977). Flowers visited by birds and bats are usually red and with only a few exceptions lack both epidermal and whole petal foldings.

It is becoming increasingly clear that the Papilionoideae have had an explosive floral radiation along a number of different lines of evolution, each of which shows increasing specialisations in structure and function linked not only to different types of pollinators but also to different breeding systems. During this investigation many thousands of flowers were dissected. It seems increasingly probable that wing petals in different species are different because the space-structure-function relationships of the different parts of the flower have changed in relation to each other, each combination probably being an optimal ecological compromise. Wing petals thus seem useful indicators of evolutionary trends that may have occurred and, if used with caution, may offer new insights for interpretative morphology, phylogeny and floral biology.

Floral biology is a fundamental discipline. By investigating the floral biology of wild plants and then incorporating this knowledge into correcting taxonomic schemes and redefining relationships much progress could be achieved in the breeding of legumes. The existence of a marker character such as wing sculpturing offers both the plant breeder and the bee breeder new possibilities; particularly as there is circumstantial evidence to suggest that different genera/species of bees and legumes may be geographically linked (Moldenke, 1979). But in the long run it is not only the sharpness of classifications, or the breeding of a few improved crops that is important, but the protection and management of the whole family of Leguminosae with its vital N_2-producing capacity.

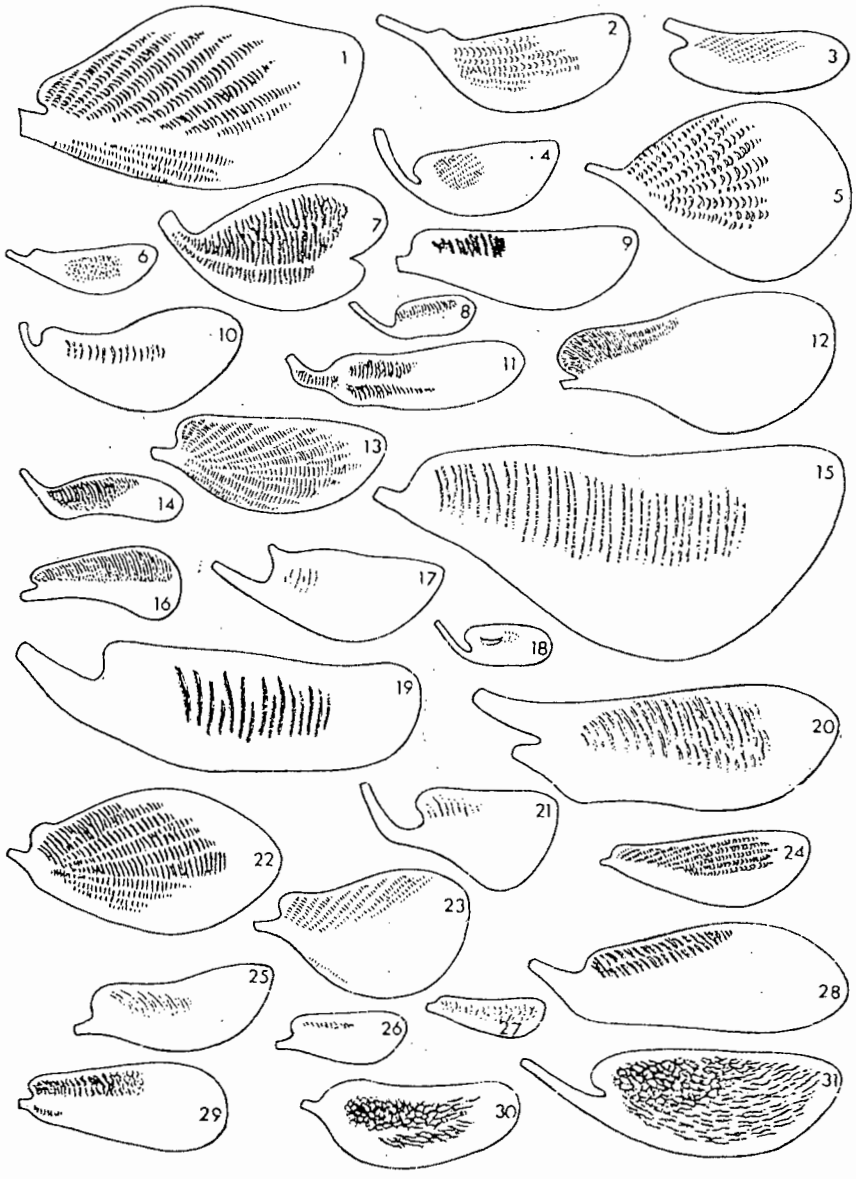


Fig. 9 Representative types of sculpturing patterns found in the Papilionoideae. 1 *Lebeckia cytisoides*, 2 *Chaetocalyx latisiliqua*, 3 *Swainsona rigida*, 4 *Smirnowia turkestanica*, 5 *Weberbauerella brongniartioides*, 6 *Vavilovia formosa*, 7 *Dipteryx polyphylla*, 8 *Buchenroedera amajubica*, 9 *Cytisus fontanesii*, 10 *Neocracca heterantha*, 11 *Coursetia glandulosa*, 12 *Platypodium elegans*, 13 *Centrolobium tomentosum*, 14 *Clathrotropis nitida*, 15 *Tephrosia vogelii*, 16 *Gompholobium polymorphum*, 17 *Wisteria floribunda*, 18 *Bisserula pelecinus*, 19 *Spathionema kilimandscharicum*, 20 *Halimodendron halodendron*, 21 *Podalyria cuneifolia*, 22 *Pericopsis mooniana*, 23 *Tipuana tipu*, 24 *Kotschya parvifolia*, 25 *Desmodium elegans*, 26 *Phylloxylon blanchetianum*, 27 *Plagiocarpus axillaris*, 28 *Sophora inhambanensis*, 29 *Vataireopsis speciosa*, 30 *Hymenolobium complicatum*, 31 *Dussia foxii* (×2.5).

Current awareness about the need for conserving rare and endangered plants and animals and, more recently, representative habitats and vegetation groups, has raised questions about how such objectives should be achieved. Management planners of 'protected areas' need to incorporate studies of floral energetics in their planning. The pollination component of any ecosystem is in a sense a major evolutionary steering-wheel. Any disruption in the energetics equilibrium of pollinators and flowers through the introduction of either new plants, whether crops or invaders, or competitive pollinators into the ecosystem could seriously alter the goals of management plans unless some criteria are available to measure the impact. Too little is known about the breeding systems and pollination and dispersal strategies, forming any particular vegetation type, to have any optimism that such criteria will be readily available to incorporate into management plans, let alone to measure the impact of disruptive biotic forces. It is only when we have an improved knowledge of floral biology as a whole that we will have any hope of being able to (1), manage ecosystems to protect rare and endangered species of plants and animals; (2), to manipulate plants and their pollinators for improved agricultural needs and finally; (3), to unravel the mysteries of the co- and contra-evolutionary development of plants and animals.

VI. Future Research

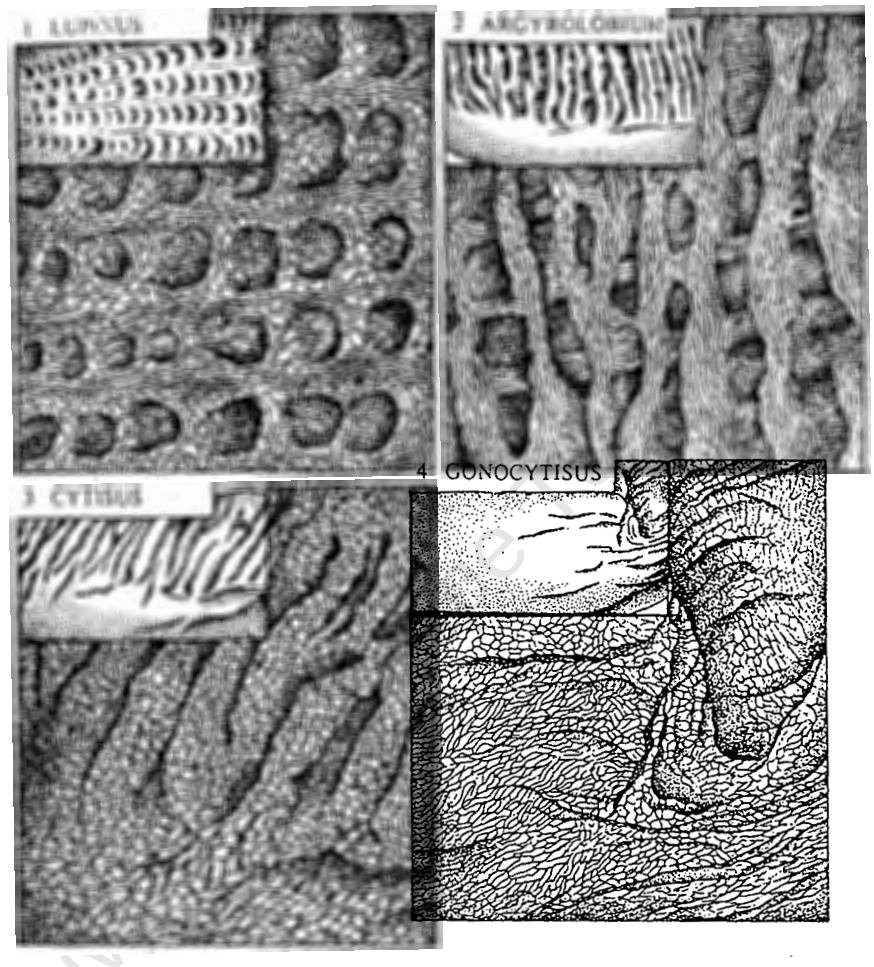
This study has involved only one aspect of the floral biology of the Papilionoideae; yet, cursory as it is, it has brought to light new taxonomic characters. Other characters of the flower which show potential promise but which have hardly been surveyed above the generic level, include: the surfaces and shapes of stigmas, anthers and petals; calyx shape and degree of fusion; intrafloral nectaries; standard appendages; anther dimorphism and micromorphology and finally petal anatomy (including vasculature).

There is a need to expand the present study with detailed investigations of petal sculpturing in the important tribes Swartzieae, Sophoreae, Dalbergieae and Desmodieae. We know very little about the evolutionary development of sculpturing and even less about the precise relationship between different sculpturing patterns and insects' feet. Bee breeders and crop breeders may well investigate these relationships with profit. An immediate project would be to determine whether the geography of different sculpturing patterns is correlated to the distribution ranges of different types of bees.

Acknowledgements

I would like to thank the Directors of the Botanical Research Institute (Pretoria) and the Royal Botanic Gardens (Kew) for access to herbarium specimens, and especially to Dr O.A. Leistner, Dr R.M. Polhill and Mr G. Lewis for reading the manuscript. Mrs. Anne Davis has drawn the figures in a patient and most exacting way. Prof. R. Dahlgren very kindly allowed me access to his data on *Aspalathus*.

Note added in press: Tewari & Nair (Phytomorphology 28: 283–290 (1979)) have described in detail the morphology of wing petals of nine Indian species of *Crotalaria*. They were able to key out the species (partly representative of Indian *Crotalaria*) satisfactorily using sculpturing and other features of the wing petal. Their description is more detailed than in this paper. They use the term cavae where I use lunae and also consider intercostal and transcostal sculpturing in greater detail. The article is well illustrated.



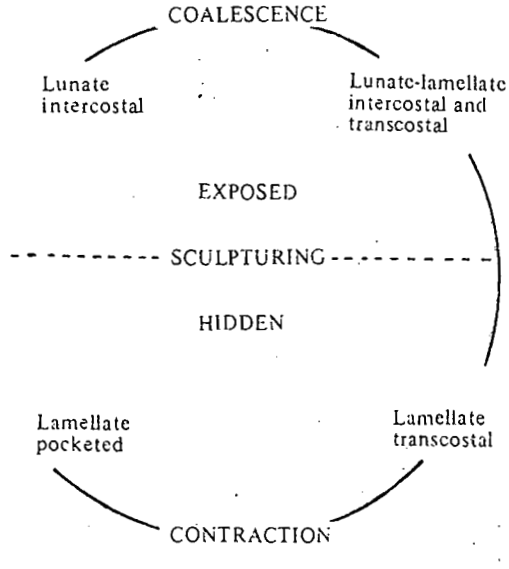


Fig. 10 Trends of petal sculpturing in Genisteae.

References

Borzos, O. Sz.- (1975). Anatomical investigations on the generative organs of *Lotus corniculatus* Agg. Acta. Bot. Hung. 21: 231–242.

Dahlgren, R. (1963). Studies on *Aspalathus* and some related genera in South Africa. Op. Bot. Soc. Bot. Lund 9 : 1–301.

Dahlgren, R. (1965). The riddle of *Walpersia* Harv. Bot. Notiser. 118: 97–103.

Dahlgren, R. (1975). Studies on *Wiborgia* Thunb. and related species of *Lebeckia* Thunb. (Fabaceae). Op. Bot. Soc. Bot. Lund 38: 1–83.

Darwin, C. (1858). On the agency of bees in the fertilization of Papilionaceous flowers and on the crossing of kidney beans. Ann. Mag. Nat. Hist. 2: 459–465.

Faegri, K. and Pijl, L. van der (1979). 'The Principles of Pollination Ecology', ed. 2. Pergamon Press, London.

Free, J.B. (1970). 'Insect pollination of crops'. Academic Press, London.

Kay, A.O.N., Daoud, A. and Stirton, C.H. (1981). Light reflection, surface micromorphology and petal chemistry. In press (Biol. J. Linn. Soc.).

Knuth, P. (1908). 'Handbook of Flower Pollination' (J.R. Ainsworth Davis, transl.), Vol. 2. Clarendon Press, Oxford.

Leppik, E.E. (1966). Floral evolution and pollination in the Leguminosae. Acta Bot. Fenn. 3: 299–308.

Moldenke, A.R. (1979). Host plant co-evolution and the diversity of bees in relation to the flora of north America. Phytologia 43: 357–419.

Narang, A.K. (1977). Some interesting features in the flower of *Crotalaria* and *Tephrosia* species. Curr. Sci. 46: 353–354.

Polhill, R.M. (1976). Genisteae (Adans.) Benth. and related tribes (Leguminosae). Bot. Syst. 1: 143–368.

Schlieden, M.J. and Vogel, Th. (1839). Beiträge zur Entwicklungsgeschichte der Blütentheile bei den Leguminosen. Nova Acta Acad. Caesar. Leop.-Carol. 19: 1.

Smettanikova, A.I. (1961). Anatomical data of *Medicago*. In 'Flora of cultivated plants of the USSR' (E.N. Senskaya, ed.), pp. 262–271. Israel program for scientific translations, Jerusalem.

Stirton, C.H. (1977). The pollination of *Canavalia virosa* by xylocopid and megachilid bees. Bothalia 12: 225–227.

CHAPTER 9

TAXONOMY

9.1 **Introduction**

The descriptions of *Otholobium* that follow are based on the author's examination of herbarium material and of populations in the field in South Africa.

9.1.1 **Sources of herbarium material**

The sources of herbarium specimens are indicated in the citations by abbreviations used in Index Herbariorum (Holmgren, Keuken and Schofield, 1981). 33 herbaria were consulted during the course of this study: AA, BM, BOL, BRUX, CN, E, G, GRA, GRAZ, HER, ISC, K, L, LINN, M, MO, NBG, NH, NU, NY, OXF, P, PRE, PRU, PRC, S, SAAS, SAM, STE, TUB, U, W, and WAG.

9.1.2 **Locality citations**

The specimen citation system used in this thesis is a modification of the Degree Reference System proposed by Edwards and Jessop (1967) and modified by Edwards and Leistner (1971). The Degree Reference System is a grid system based on latitude and longitude. The basic unit is the one degree square of latitude and longitude (Edwards & Jessop, 1967).

This square is named by the degree of latitude of the NW or top left hand corner. This one degree square is divided into four half degree squares (30' X 30') numbered A, B, C, and D from left to right and top to bottom (Fig. 9.1a).

Each half degree square is further divided into quarter degree squares (15' X 15') and these are again numbered A, B, C and D from left to right and top to bottom.

In this study the designation of a particular square , or portion of a square, is given by the degree reference only. For example, 25°45'S - 26°00' by 28°00'E - 28°15'E is given as **2528CC** (shaded area in Fig. 9.1). The 2528 is read as twenty five - twenty eight.

Countries and degree squares are cited in the enumeration from north to south and from west to east.

I have not discriminated at either the Provincial or "Independent TBVC States" level as with the "fragmentation" of the country it is no longer possible to discover precisely to which State a specimen belongs. In any case, these areas have no biological value and an inspection of the distribution maps provided will give a more meaningful and rapid visual impression of the distribution ranges.

9.1.3 **Specimen citations**

I have seen and annotated all of the 1536 specimens of *Otholobium* enumerated in the species accounts.

9.2 The genus *Otholobium*

The following generic description is a modified description of the original description given in Stirton (1981b) and is based on the 53 species studied.

Otholobium C.H. Stirton in Adv. Leg. Systematics 1,2: 341 (1981).

Small trees, shrubs, suffrutices, or herbs. **Leaves** unifoliolate or trifoliolate, stipulate, subsessile or petiolate, entire, nigro-punctate or pellucid-dotted, mostly recurved-mucronate; stipules evident, striate, adnate to the base of the petiole. **Flowers** sessile to pedicellate, bracteate, aggregated in 1 or 5 -- 50 triplets (rarely doublets) on axillary or terminal fascicles, imperfect racemes or lax pseudo-spikes, each triplet subtended by a *solitary* bract; cupulum absent. **Calyx** campanulate, 5-lobed, the lowest lobe usually longer than the rest; vexillar lobes generally fused to some degree above the tube. **Standard** scarcely reflexed vertically, auricles weakly developed, appendages absent. **Wing petals** with lamellate sculpturing pattern; distal edges of wings characteristically overlapping and rounded. **Keel petals** purple-tipped on inner face of apices, fused along lower edges, free along upper edges. **Androecium** diadelphous or pseudomonadelphous, vexillary stamen free or variously fused to androecial sheath; anthers uniform, alternately basifixed and medifixed. **Pistil** uniovulate; style bent with entasis developed on the bend, stigma capitate. **Fruit** swollen, indehiscent, pubescent, papery or cartilaginous. **Seeds** compressed, longer than broad.

DIAGNOSTIC KEY TO 53 SPECIES OF *OTHOLOBIUM*.

KEY version: 15-JUL-88. Run at 16:28 on 10-NOV-88.

Characters - 102 in data, 102 included, 56 in key.
Items - 53 in data, 53 included, 53 in key.

RBASE = 1.80 ABASE = 1.80 REUSE = 1.01 VARYWT = .10
Number of confirmatory characters = 4

Average length of key = 6.9 Average cost of key = .7
Maximum length of key = 10 Maximum cost of key = 1.3

Character reliabilities 1-2,8 3-6,5 7,7 8-9,5 10,4 11,7 12,8 13-14,10 15,4 16,5 17,9 18,7 19-20,8 21,5 22,4 23,5 24,6 25,9 26,7 27,9 28,7 29,10 30,8 31,7 32,5 33,4 34-35,7 36-38,6 39,7 40-41,6 42-44,8 45,9 46,5 47,8 48-53,6 54-56,4 57,5 58,7 59-60,6 61-63,7 64,9 65,7 66-70,5 71,3 72,6 73,4 74,6 75,5 76,8 77-78,6 79,2 80-82,5 83,7 84,8 85,5 86,6 87,4 88-89,9 90-91,5 92,7 93,5 94-95,9 96-102,5

1(0). Fruits papery..... 2
Fruits cartilaginous..... 44

2(1). Leaves subsessile..... 3
Leaves petiolate..... 18

3(2). Leaves unifoliolate..... O. lanceolatum 1.
Leaves 3-foliolate..... 4

4(3). Lateral leaflets symmetrical..... 5
Lateral leaflets asymmetrical..... 12

5(4). Leaves digitately trifoliolate..... 6
Leaves pinnately trifoliolate..... 11

6(5). Glands more dense on upper surface..... 7
Glands more or less equal in number on both surfaces..... 9

7(6). Branches pustulate; style glabrous; glands black; seeds uniformly coloured; filament of vexillar stamen fused to androecial sheath along its lower third to fused to androecial sheath for half or more of its length..... 8
Branches non-pustulate; style hairy; glands yellow, orange or hyaline; seeds mottled; filament of vexillar stamen free from androecial sheath..... O. hirtum 2.

8(7). Leaves conduplicate; apex of inflorescence overtopped by subtending leaves to about equal in length to subtending leaves; lateral leaflets half to two thirds the length of the terminal leaflet; leaves narrowly obovate; the vexillar calyx lobes fused for more than half their length above the tube..... O. rubicundum 3.
Leaves partly conduplicate; apex of inflorescence overtopping

subtending leaves; lateral leaflets up to half the length of the terminal leaflet; leaves obovate; the vexillar calyx lobes fused for one third to one half their length..... O. hamatum 4.

9(6). Branches pustulate; leaves narrowly obovate; triplet bracts caducous; stipules caducous; calyx glands equally distributed on tube and teeth..... O. candicans 5.
Branches non-pustulate; leaves obovate; triplet bracts persistent; stipules persistent; calyx glands more densely concentrated on the teeth..... 10

10(9). Leaves conduplicate; inflorescences lax; apex of inflorescence overtopped by subtending leaves to about equal in length to subtending leaves; large shrubs; stems semi-erect to ascending... ..... O. spissum 6.
Leaves partly conduplicate; inflorescences congested; apex of inflorescence overtopping subtending leaves; small shrubs; stems decumbent..... O. sabulosum 7.

11(5). Glands more dense on upper surface; calyx shorter than corolla; leaves conduplicate; apex of inflorescence overtopping subtending leaves; 150 cm tall or more..... O. arborescens 8.
Glands more dense on lower surface; calyx about equal in length to corolla; leaves partly conduplicate; apex of inflorescence overtopped by subtending leaves to about equal in length to subtending leaves; up to 10 cm tall..... O. uncinatum 9.

12(4). Leaves digitately trifoliolate..... 13
Leaves pinnately trifoliolate..... O. bolusii 10.

13(12). Glands visible with a x10 hand lens; ovary stipitate..... 14
Glands not visible with a x10 hand lens; ovary sessile..... 17

14(13). Glands more dense on upper surface; stems branching in lower parts. 15
Glands more or less equal in number on both surfaces; stems branching in upper parts..... 16
Glands more dense on lower surface; stems branching at the base.... ..... O. macradenium 11.

15(14). Calyx shorter than corolla; inflorescences lax; apex of inflorescence overtopping subtending leaves; the vexillar calyx lobes fused above the tube; stipules caducous..... O. bowieanum 12.
Calyx about equal in length to corolla; inflorescences congested; apex of inflorescence overtopped by subtending leaves to about equal in length to subtending leaves; the vexillar calyx lobes free above the tube; stipules persistent..... O. saxosum 13.

16(14). Leaves partly conduplicate; apex of inflorescence overtopping subtending leaves; glands distinctly raised above the surface; lateral leaflets left half wider; calyx tube calyx tube longer than calyx teeth..... O. acuminatum 14.
Leaves displayed; apex of inflorescence overtopped by subtending leaves to about equal in length to subtending leaves; glands impressed; lateral leaflets right half wider; calyx tube calyx tube shorter than calyx teeth..... O. heterosepalum 15.

17(13). Leaves conduplicate; branches vestiture comprised of brown, yellowish or blackish hairs; the vexillar calyx lobes fused for up to one third their length above the tube; seeds uniformly coloured; stipules persistent..... O. carneum 16.
Leaves partly conduplicate; branches vestiture comprised of white or silvery hairs; the vexillar calyx lobes fused for more than half their length above the tube; seeds mottled; stipules caducous..... O. polyphyllum 17.

18(2). Glands visible with a x10 hand lens..... 19
Glands not visible with a x10 hand lens..... 40

19(18). Leaves unifoliolate; lignotuber with spreading underground stems... 20
Leaves 3-foliolate; simple woody rootstock..... 21

20(19). Small shrubs; stems semi-erect to ascending; branches vestiture comprised of white or silvery hairs; the carinal calyx teeth broader than other four teeth; the vexillar calyx lobes fused for more than half their length above the tube..... O. rotundifolium 18.
Herbs; stems erect; branches vestiture comprised of brown, yellowish or blackish hairs; the carinal calyx teeth about equal in width to other four teeth; the vexillar calyx lobes fused for up to one third their length above the tube..... O. accrescens 19.

21(19). Lateral leaflets symmetrical..... 22
Lateral leaflets asymmetrical..... 28

22(21). Leaves digitately trifoliolate; triplet bracts single-toothed... 23
Leaves pinnately trifoliolate; triplet bracts multi-toothed..... 27

23(22). Glands more dense on upper surface; inflorescences lax; claw of standard petal short and broad..... 24
Glands more or less equal in number on both surfaces; inflorescences congested; claw of standard petal elongated and narrow..... 25

24(23). Branches pustulate; leaves displayed; style glabrous; small shrubs; leaves oblanceolate..... O. racemosum 20.
Branches non-pustulate; leaves partly conduplicate; style hairy; large shrubs; leaves broadly elliptic..... O. flexuosum 21.

25(23). Calyx shorter than corolla; stipules subulate; stipules clasping; flowers pedicellate; flower bracts lanceolate..... 26
Calyx about equal in length to corolla; stipules lanceolate; stipules patent to recurved; flowers sessile; flower bracts ovate..... O. fruticans 22.

26(25). Leaves conduplicate; inflorescences up to 3 number of triplets per inflorescence; apex of inflorescence overtopped by subtending leaves to about equal in length to subtending leaves; branches non-pustulate; leaves obovate..... O. virgatum 23.
Leaves partly conduplicate; inflorescences 10 to 15 number of triplets per inflorescence; apex of inflorescence overtopping subtending leaves; branches pustulate; leaves broadly obovate....

..... O. bracteolatum 24.

27(22). Glands more dense on upper surface; fruits enclosed by calyx at maturity; branches non-pustulate; leaves partly conduplicate; inflorescences lax..... O. striatum 25.
Glands more or less equal in number on both surfaces; fruits mostly protruding from calyx at maturity; branches pustulate; leaves conduplicate; inflorescences congested..... O. trianthum 26.

28(21). Glands more dense on upper surface..... 29
Glands more or less equal in number on both surfaces..... 32

29(28). Leaves digitately trifoliolate; branches non-pustulate; triplet bracts persistent; calyx glands more densely concentrated on the teeth; mucro of terminal leaflets straight to arching to patent..
..... 30
Leaves pinnately trifoliolate; branches pustulate; triplet bracts caducous; calyx glands equally distributed on tube and teeth; mucro of terminal leaflets recurved..... O. pustulatum 27.

30(29). Calyx shorter than corolla; inflorescences congested; large shrubs; leaves obovate; glands black..... 31
Calyx about equal in length to corolla; inflorescences lax; small shrubs; leaves oblanceolate; glands yellow, orange or hyaline....
..... O. pungens 28.

31(30). Inflorescences up to 3 number of triplets per inflorescence; flowers maturing more or less simultaneously; apex of inflorescence overtopped by subtending leaves to about equal in length to subtending leaves; glands impressed; stipules subulate.
..... O. prodiens 29.
Inflorescences 16 number of triplets per inflorescence or more; flowers maturing sequentially; apex of inflorescence overtopping subtending leaves; glands distinctly raised above the surface; stipules broadly obliquely ovate..... O. spicatum 30.

32(28). Branches pustulate..... 33
Branches non-pustulate..... 36

33(32). Leaves partly conduplicate; lateral leaflets left half wider; the vexillar calyx teeth falcate; apex of terminal leaflets retuse; calyx glands variable in size..... O. mundianum 31.
Leaves displayed; lateral leaflets right half wider; the vexillar calyx teeth straight; apex of terminal leaflets obtuse; calyx glands constant in size..... 34

34(33). Inflorescences lax; stipules subulate; triplet bracts multi-toothed; the androecial sheath fused basally, free distally to free basally, fused distally; stigma not penicillate.....
..... O. lucens 32.
Inflorescences congested; stipules broadly obliquely ovate; triplet bracts single-toothed; the androecial sheath split adaxially along its entire length; stigma penicillate..... 35

35(34). Inflorescences up to 3 number of triplets per inflorescence; apex of inflorescence overtopped by subtending leaves to about equal

in length to subtending leaves; style glabrous; large shrubs; glands black..... O. nitens 33.
Inflorescences 16 number of triplets per inflorescence or more; apex of inflorescence overtopping subtending leaves; style hairy; small shrubs; glands yellow, orange or hyaline.... O. parviflorum 34.

36(32). Calyx shorter than corolla; inflorescences congested; large shrubs; ovary hairy..... 37
Calyx about equal in length to corolla; inflorescences lax; small shrubs; ovary glabrous..... 38

37(36). Leaves partly conduplicate; glands distinctly raised above the surface; stipules broadly obliquely ovate; calyx tube calyx tube equal in length to calyx teeth; the carinal calyx teeth broader than other four teeth..... O. stachyerum 35.
Leaves displayed; glands impressed; stipules narrowly triangular;

calyx tube calyx tube shorter than calyx teeth; the carinal calyx teeth about equal in width to other four teeth..... O. pictum 36.

38(36). Inflorescences up to 3 number of triplets per inflorescence; flowers maturing more or less simultaneously; apex of inflorescence overtopped by subtending leaves to about equal in length to subtending leaves; glands black; branches vestiture comprised of brown, yellowish or blackish hairs..... 39
Inflorescences 4 to 9 number of triplets per inflorescence; flowers maturing sequentially; apex of inflorescence overtopping subtending leaves; glands yellow, orange or hyaline; branches vestiture comprised of white or silvery hairs..... O. venustum 37.

39(38). Stipules subulate; the vexillar calyx lobes free above the tube; triplet bracts persistent; triplet bracts multi-toothed; flower bracts lanceolate..... O. piliferum 38.
Stipules broadly obliquely ovate; the vexillar calyx lobes fused above the tube; triplet bracts caducous; triplet bracts single-toothed; flower bracts linear..... O. obliquum 39.

40(18). Calyx shorter than corolla..... 41
Calyx about equal in length to corolla..... O. swartbergense 40.
Calyx longer than the corolla..... O. sericeum 41.

41(40). Leaves conduplicate..... O. argenteum 42.
Leaves partly conduplicate..... O. zeyheri 43.
Leaves displayed..... 42

42(41). Leaves unifoliolate; herbs; wing petals longer than keel petals; style hairy; the carinal calyx teeth broader than other four teeth..... 43
Leaves 3-foliolate; small shrubs; wing petals shorter than keel petals; style glabrous; the carinal calyx teeth about equal in width to other four teeth..... O. incanum 44.

43(42). Branches vestiture comprised of white or silvery hairs; the vexillar calyx lobes free above the tube; standard petal auricles weakly developed to auricles absent; stipules hairy; never forming dense clumps..... O. thomii 45.
Branches vestiture comprised of brown, yellowish or blackish hairs;

the vexillar calyx lobes fused above the tube; standard petal auricles prominent; stipules glabrous; forming dense clumps..... ..... O. dreweae 46

44(1). Lateral leaflets symmetrical..... 45
Lateral leaflets asymmetrical..... 47

45(44). Leaves digitately trifoliolate; branches non-pustulate; flowers maturing more or less simultaneously; triplet bracts persistent; standard petal auricles prominent..... 46
Leaves pinnately trifoliolate; branches pustulate; flowers maturing sequentially; triplet bracts caducous; standard petal auricles weakly developed to auricles absent..... O. caffrum 47.

46(45). Leaves partly conduplicate; leaves subsessile; apex of inflorescence overtopped by subtending leaves to about equal in length to subtending leaves; style hairy; glands distinctly raised above the surface..... O. gazense 48.
Leaves displayed; leaves petiolate; apex of inflorescence overtopping subtending leaves; style glabrous; glands impressed..

..... O. wilmsii 49.

47(44). Leaves digitately trifoliolate; fruits mostly protruding from calyx at maturity; flowers maturing more or less simultaneously; apex of inflorescence overtopped by subtending leaves to about equal in length to subtending leaves..... 48
Leaves pinnately trifoliolate; fruits partly protruding from calyx at maturity; flowers maturing sequentially; apex of inflorescence overtopping subtending leaves..... O. fumeum 50

48(47). Natal, or Transvaal; inflorescences lax; glands impressed; calyx tube calyx tube longer than calyx teeth; standard petal auricles prominent..... O. nigricans 51
Cape Province; inflorescences congested; glands distinctly raised above the surface; calyx tube calyx tube equal in length to calyx teeth; standard petal auricles weakly developed to auricles absent..... 49

49(48). Kenya, or Malawi; leaves subsessile; style glabrous; branches non-pustulate; inflorescences 4 to 9 number of triplets per inflorescence..... O. foliosum 52
South Africa; leaves petiolate; style hairy; branches pustulate; inflorescences up to 3 number of triplets per inflorescence..... ..... O. polystictum 53

1. Otholobium lanceolatum C.H. Stirton *sp. nov. O. zeyheri affinis sed caulibus pustulatis folius nigro-punctatis inflorescentiis folia duplo excedentis floribus magnis albis vel pallide caeruleis, alis in apice superiore purpureo-maculatis differt.*

Typus: 3418 (Caledon): between Drievlei and Morning View farms (--AD), 13-1-1986, *Stirton 11381* (K, holo; MO, NBG, PRE, iso).

Suffrutex parvus sparse foliatus usque 60 mm altus; post incendia novibus ramis e base orientibus. Caules usque septimi, 9 -- 15 cm longi, rariter in axile inferiore ramosi, decumbentes, foliis basalibus minimis. Folia unifoliolata, 25 -- 36 mm longa, 6 -- 9 (10) mm lata, elliptica, glabra, cuspidata, apice acuta, base cuneata, in sicco dense nigro-punctata, margine glandulosa, juvenalia glabra, costa inferne prominente, nervis lateralibus utrinque prominulis, rhachide carente; petiolus 2 mm longus; petiolulus 1 mm longus. Stipulae 3 -- 5 mm longae, 0,5 -- 2,0 mm latae, quam petioli longiores, glabrae, subulatae, acuminatae, costatae, glandulosae. Inflorescentiae axillares, 1 -- 2 in axilibus superioribus, in ramulis brevibus annuis terminales, oblongae, 25 -- 35 mm longae; flores pedicellati in gregibus 5 -- 9 trifloris aggregati grege omni a bractea flabellata vel late ovato-oblonga glanduloso maculata pilosa caduca subtenta; pedunculis 25 -- 35 mm longus, verruculis 0,2 mm altis dense obtectus, circiter duplo folium a qua subtentus excedens. Flores albi, 8 -- 10 mm longi omnes a bractea anguste lanceolata vel linearis 3 mm longa subtenta. Dentes calycis quam tubus 2 -- 3 mm longus longiores, inaequales, acutae; dens carinalis latissimus, 10 -- 11 mm longus, 2,0 -- 2,5 mm latus, atro-viridis; calyx cetero pallide luteo-viridis, lobi vexillares falcati, laterales aequantes, dentibus in tertio inferiore connati, extus pilis 1,5 -- 2,0 mm longis albis patentibus et glandulis numerosis parvis dense obtecti intus glabri. Vexillum 13 mm longum, 8 -- 9 mm latum, obovatum sed oblongum; album vel pallide caeruleum, glabrum. Alae 10 -- 12 mm longae, 3 -- 4 mm latae, carina excedentes. Petala carinae 9 mm longa, 2,5 -- 3,0 mm lata. Androecium 8 mm longum, stamine decimo libero, fenestratum.

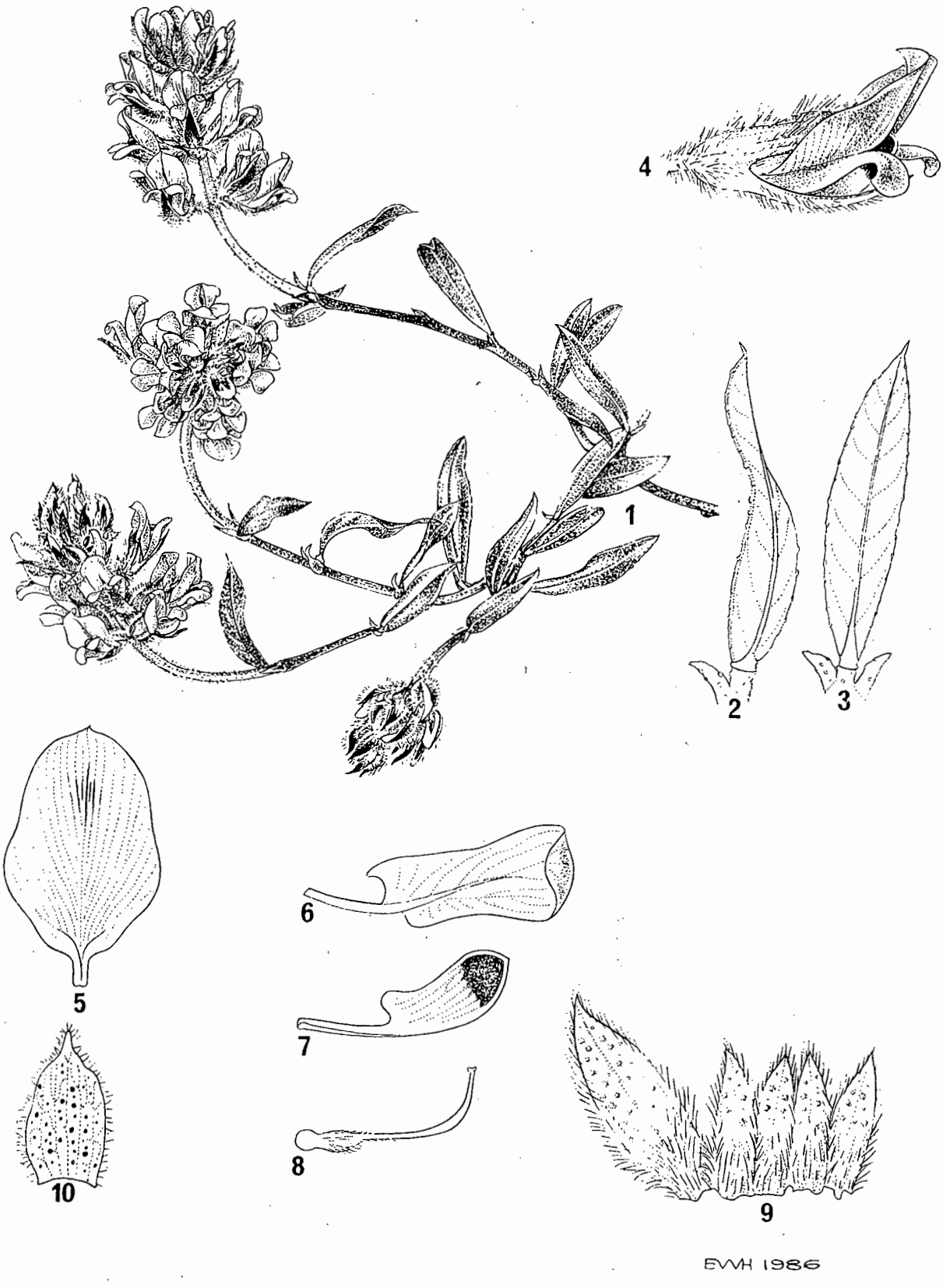


Fig. 9.1 *Otholobium lanceolatum*. 1, Flowering branches, x1; 2, Leaflet from seasonal shoot, x2; 3, Leaflet from overseasonal shoot, x2; 4, Side view of flower, x5; 5, Standard, x4; 6, Wing petal, x4; 7, Keel petal, x4; 8, Pistil, x4; 9, Calyx opened out, outer face, x4; 10, Triplet bract, x10 (*Stirton 11381*).

Pistillum 8 mm longum; ovarium 1,8 -- 2,0 mm longum, stipe 1 mm longo glabro, tomentosum, parte curvata 2,5 -- 2,8 mm alta, ante partem flexuosam incrassatum; stylus prorsus inclinatus, usque ad entasim sparse pilosus; stigma paulum penicillatum. Fructus seminaque ignoti.

Small, decumbent, sparsely leaved suffrutex up to 60 mm high; coppicing after fires. **Stems** up to seven, 9 -- 15 cm long, occasionally branched in one of the lower axils, basal leaves smallest; densely pustulate; basal parts of the shrub thick and woody, much gnarled. **Leaves** unifoliolate, 25 -- 36 mm long, 6 -- 9 (10) mm wide, elliptic, glabrous, cuspidate, mucro straight, apex acute, base cuneate, densely nigro-punctate when dried, margin glandular, younger leaves glabrous, midrib prominent below, secondary veins on both surfaces raised but less prominent; rachis absent; petiole 2,0 mm long; petiolule 1 mm long. **Stipules** 3,0 -- 5,0 mm long, 0,5 -- 2,0 mm wide, longer than petioles; glabrous, subulate, acuminate, glabrous, ribbed, glandular. **Inflorescences** axillary, 1 -- 2 in upper axils, terminating short seasonal shoots, oblong, 25 -- 35 mm long, comprised of 5 -- 9 triplets of flowers with 2 -- 4 mm long pedicels, each set subtended by a flabellate to broadly ovate-oblong, gland-dotted hairy bract, caducous; peduncle 25 -- 35 mm long, densely covered in 0,2 mm high warts; about twice the length of the subtending leaf. **Flowers** white, 8 -- 10 mm long, each subtended by a narrowly lanceolate to linear 3 mm long caducous bract. **Calyx teeth** longer than the 2 -- 3 mm long tube, unequal, acute; carinal tooth broadest, 10 -- 11 mm long, 2,0 -- 2,5 mm wide, dark green, rest of calyx pale yellowish green; vexillar lobes falcate, same length as the lateral lobes, fused for one third their length above the tube, outer face densely covered in 1,5 -- 2,0 mm long white patent hairs and many small glands, glabrous on inner face. **Standard** 13 mm long, 8 -- 9 mm wide, claw 2 mm long, obovate, but oblong when reflexed; white to pale blue, auriculate, claw narrowed. **Wing petals** 10 -- 12 mm long, 3 -- 4 mm wide, claw 3 mm

long; cultrate, upcurving relative to keel, auriculate, claw 3 mm long, longer and very lightly fused to keel petals; sculpturing upper right central, sometimes upper distal, bottom row intracostal, upper two rows transcostal, each row comprised of up to 25 transverse lamellae. **Keel petals** 9 mm long, 2,5 -- 3,0 mm wide, claw 4 mm long, purple-tipped. **Androecium** 8 mm long, vexillar stamen free, fenestrate; anthers equal, 0,3 mm long. **Pistil** 8 mm long; ovary 1,8 -- 2,0 mm long, stipe 1 mm long and glabrous, tomentose; height of curvature 2,5 -- 2,8 mm, thickened before flexure; style forward sloping, sparsely hairy up to entasis; stigma slightly penicillate. **Seeds** and fruits unknown. Fig. 9.1.

Otholobium lanceolatum is endemic to the northern foothills of Shaw's Mountain (Fig. 9.2). It grows on clayish stony slopes in mesic mountain fynbos. After three attempts to trace the original locality of Miss Barker's and Miss Esterhuysen's first collection of this species I was fortunate, in the company of Dr. Ion Williams, to rediscover it some 5 km away from Shaw's Mountain. The population we discovered numbered about 45 plants and was part of a remnant pocket of fairly undisturbed vegetation. Little else is known about this species. It flowers from early November to December.

This distinctive and attractive species is separated from its allied species by the combination of its decumbent habit, pustulate stems, short oblong inflorescences twice the length of the leaves, white patent haired and densely glandular calyx, large white flowers, purple patch on the upper tip of the wing petals and finely pubescent ovary with forward sloping style.

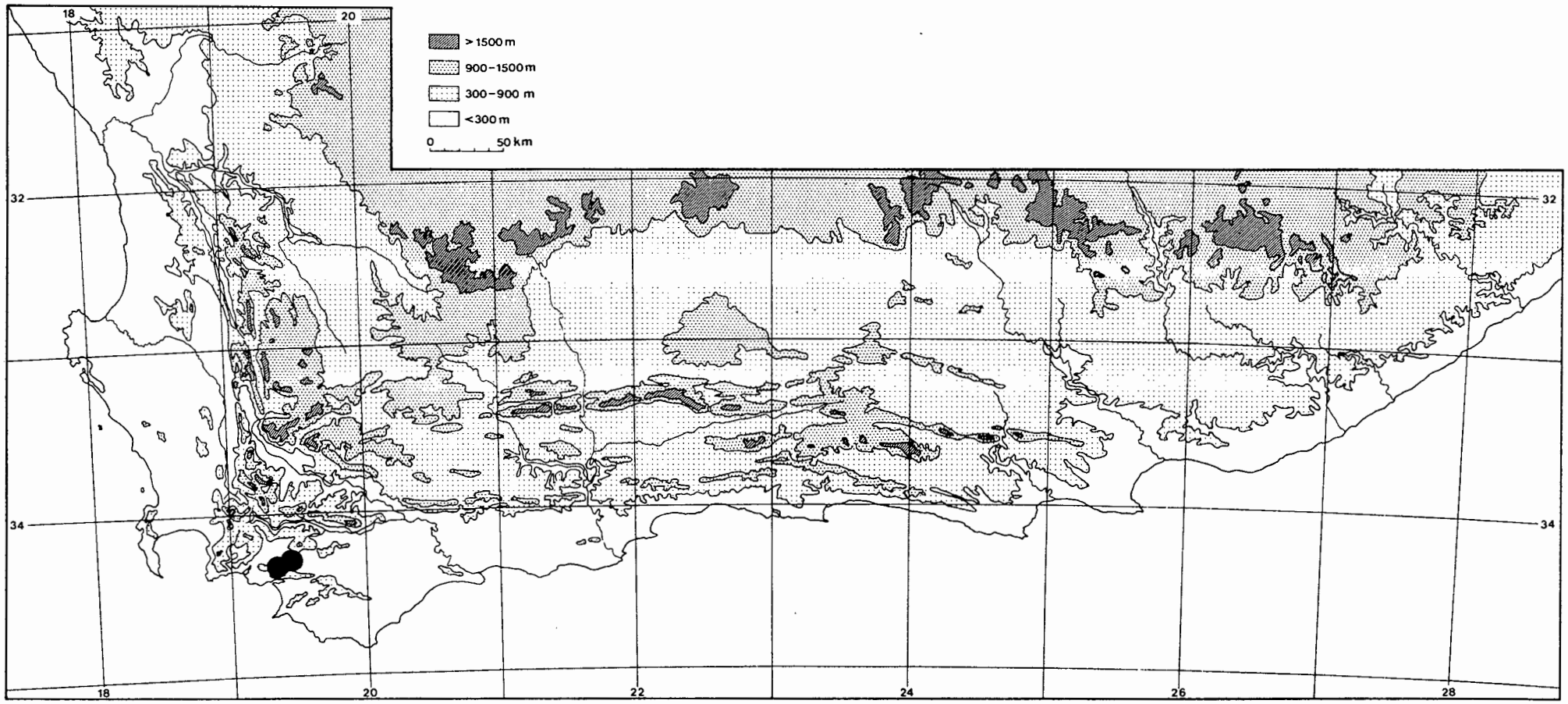


Fig. 9.2 Known distribution of *Otholobium lanceolatum* C.H. Stirton in southern Africa.

Specimens examined

-3419 (Caledon): Shaw's Mountain (--AD), 1-12-1951, *Barker 7622* (NBG); 1-12-1951, *Esterhuysen 19281* (BOL); near the Old Road Works Department camping site, between Drievlei and Morning View farms (--AD), 13-1-1986, *Stirton 11100* (K); 13-1-1986, *Stirton 11381* (K, MO, NBG, PRE).

2. Otholobium hirtum (L.) C.H. Stirton in S. Afr. J. Bot. 52,1: 3 (1986).

Psoralea hirta L., Pl. Rar. Afr. 15 (1760) non Willd. (1802). Kidd, Wildflow. Cape Penins. t.70 (1950); Adamson & Salter, Fl. Cape Penins. 487 (1950). Neotype: Leeurivier, between Wolsely and Tulbagh, 4-12-1981, *Stirton 10126* (K). It has been very difficult to establish what might be the type of this species. The sheets named *hirta* in L.f.'s hand in LINN (928.15 and 928.17) are all *Otholobium decumbens* (Ait.) C. H. Stirton and it appears that he misinterpreted his father's concept of *hirta*. LINN 928.15 is a mixed sheet with four pieces. LINN 928.17 was originally named *Psoralea aculeata* and is marked "Tulbagh List c.1769 no. 60". Both these collections postdate the original publication of *P. hirta* so are not available for lectotypification. There are no sheets of *hirta* in S.

P. stachydis L.f., Suppl. 338 (1781); Gmelin, Syst. nat. ed. 13, 2: 1138 (1791); Poir. in Lam., Encycl. 5: 689 (1804); DC., Prodr. 2: 218 (1825); Walp. in Linnaea 13: 515 (1839); Harv. in Harv. & Sond., Fl. Cap. 2: 152 (1862); Forbes in Bothalia 3: 314 (1930). Holotype: "Habitat in Cap. Bonae Spei", *Thunberg* s.n. (LINN 928.10).

P. stachyos Thunb., Prodr. 136 (1800) nom. illegit.; E. Mey. in Linnaea 7: 165 (1832); Eckl. & Zeyh., Enum. 231 (1836); Harv. in Harv. & Sond., Fl. Cap. 2: 608 (1862).

P. hirta L. var. *jacquiniana* DC., Prodr. 2: 217 (1825); Jacq., Hort. Schoenbr. 2: t. 228 (1797). Holotype: Without locality, *Sonnerat* s.n. (P-JA).

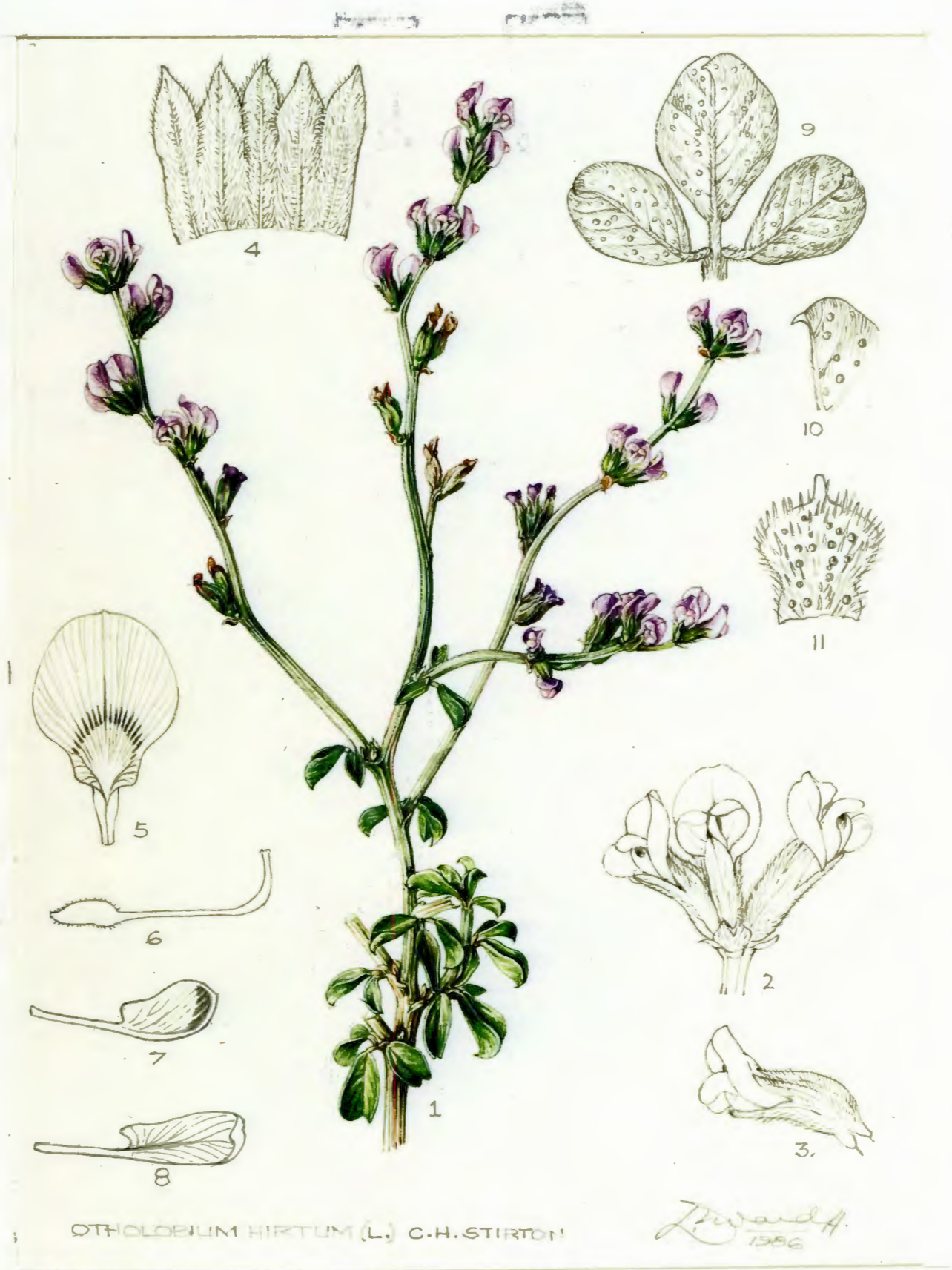


Fig. 9.7 *Otholobium hirtum* (L.) C.H. Stirton

Erect shrub up to 2 m tall, branching close to the ground, rounded to spreading. **Branches** curved to erect; each season's growth fan-like, producing shoots up to 50 cm long; sparsely-leaved, rigid, cano-pubescent. **Leaves** digitately trifoliolate, shortly petiolate. **Leaflets** 11 -- 25 mm long, 6 -- 15 mm wide, broadly cuneate-obovate or obcordate, recurved mucronate, mucro slender, sharply recurved, up to 2 mm long; apex obtuse to emarginate, base cuneate, partially conduplicate, spreading, orange-dotted when dried, pellucid when fresh; appressed pubescent on both surfaces; petiole 1 -- 2 mm long; petiolules 1 mm long, sericeous. **Stipules** 3 -- 5 mm long, <1 mm wide, subulate, slender. **Synflorescence** 15 -- 22 cm long, usually with a short innovation zone up to 5 cm long; main florescence 4 -- 12 cm long, being 9 -- 18-flowered; basal paracladia longest, up to 10 cm long and 6 -- 18 -flowered; flowers borne in duplets or triplets, each set subtended by a 2 -- 4 mm long, broadly ovate or naviculate bract, gland-dotted, sericeous. **Flowers** 7 -- 12 (12) mm long, mauve to white with purple flush; flower bract 5 mm long, 2 mm wide, somewhat flabellate or shortly truncate, linear, hairy at apex. **Calyx teeth** longer than the tube, unequal, triangular, carinal tooth broader and longer than other teeth; 8,0 -- 8,5 mm long, 1,8 -- 2,0 mm wide, vexillar lobes fused higher up than rest; white sericeous, flushed purple, glandular especially on teeth; somewhat accrescent in fruit. **Standard** 8,5 -- 9,5 mm long, 5,0 -- 7,0 mm wide, mauve, nectar guide a broad white M-shape flecked with dark mauve, obovate, sides flared, apex rounded, distinctly auriculate; claw 3,5 mm long, narrow. **Wing petals** 8 - 9 mm long, 2 mm wide; claw 3,5 mm long, exceeding keel petals, tips mauve; sculpturing upper central comprising 12 -- 15 inter- and intra-costal lamellae, rows 2 -- 3, diffuse. **Keel petals** 6,0 -- 6,5 mm long, 1,8 -- 2,0 mm wide, apex rounded, claw 5 mm long, longer than blade, nectar guide black with violet halo. **Androecium** 8 mm long, vexillar stamen free, androecial sheath split adaxially. **Pistil** 7,0 -- 7,5 mm long; ovary 2 mm long, moderately glandular and hairy in upper half; style maximally thickened at flexure, height of curvature 2 mm; stigma papil-

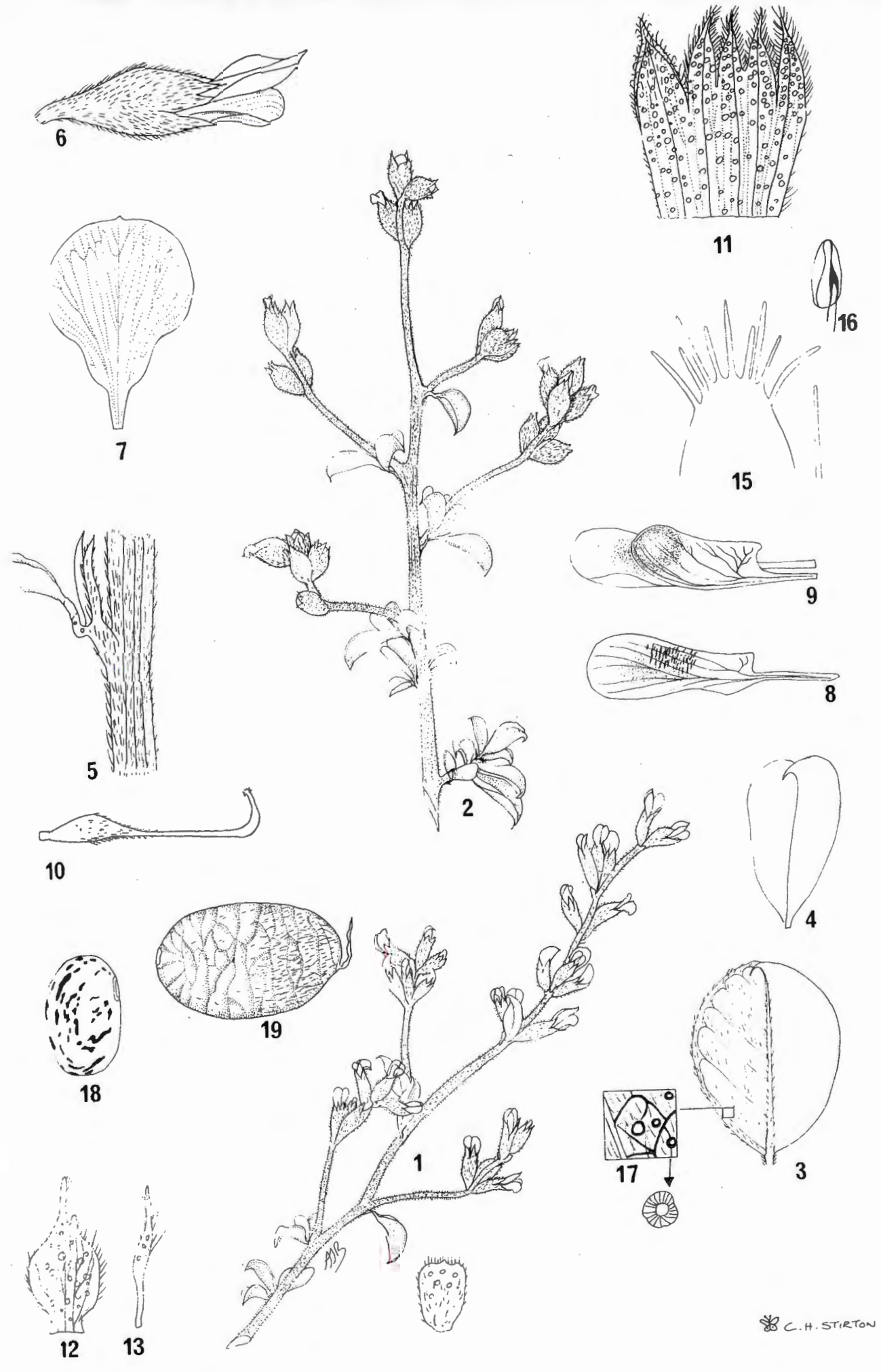


Fig. 9.3 *Otholobium hirtum*. 1, Flowering shoot, x1; 2, Fruiting branch, x1; 3, Leaf subtending branches, x4; 4, Terminal leaflet from a short shoot, x4; 5, Stipules and portion of stem, x4; 6, Flower, x5; 7, Standard, x5; 8, Wing petal, x5; 9, Wing petal and keel petal, x5; 10, Pistil, x6; 11, Calyx opened out, outer face, x6; 12, Triplet bract, x6; 13, Flower bract, x6; 14, Stipule, x6; 15, Upper part of filaments, x10; 16 Anther, x20; 17, Detail of leaf surface; 18, Seed, x6; 19, Fruit, x6 (*Stirton 10337*).

lose, penicillate, slightly inflexed. **Fruit** 7 mm long, 4 mm wide, papery thin, finely pubescent, reticulate. **Seed** 3 mm long, 2 mm wide, khaki or chestnut brown, covered with black flecks and blotches. Fig. 9.3.

Otholobium hirtum is a widespread and fairly common pioneer communal plant of disturbed sites, Fig. 9.4, being especially common wherever roadworks have been carried out (Fig. 9.4). It was probably formerly restricted to higher lying areas of the south-western Cape than those which it now occupies. Fig. 9.5. Flowering takes place from October to December with a marked peak in October.

The material named *O. stachydis* in some herbaria would at first glance appear to be a distinct but closely allied species (Fig. 9.6). The northernmost representatives are certainly easily separated from typical *O. hirtum* by their longer inflorescences, larger and more numerous flowers, densely shaggy stems and black shaggy calyces. Typical of this variant are the following specimens: *Bolus 7529*, *Bond 561*, *Esterhuysen 30390*, *Leighton 125*, *Pillans 7816*, *8634*, *Stirton 10202*. These clearcut differences break down as one passes from the higher ground onto the lowlands. There is a gradual cline of increasing black pubescence as one goes north from Cape Town (Fig. 9.7). The Piquetberg populations need further investigation in the field. They have much darker greener leaves and are more pungent smelling (Fig. 9.6). This northern group could, with further field work in the intervening areas, turn out to be a distinct taxon.

Specimens examined

-3217 (Vredenburg): Witklip farm (--DD), 16-10-1975, *Boucher 2901* (PRE, STE).

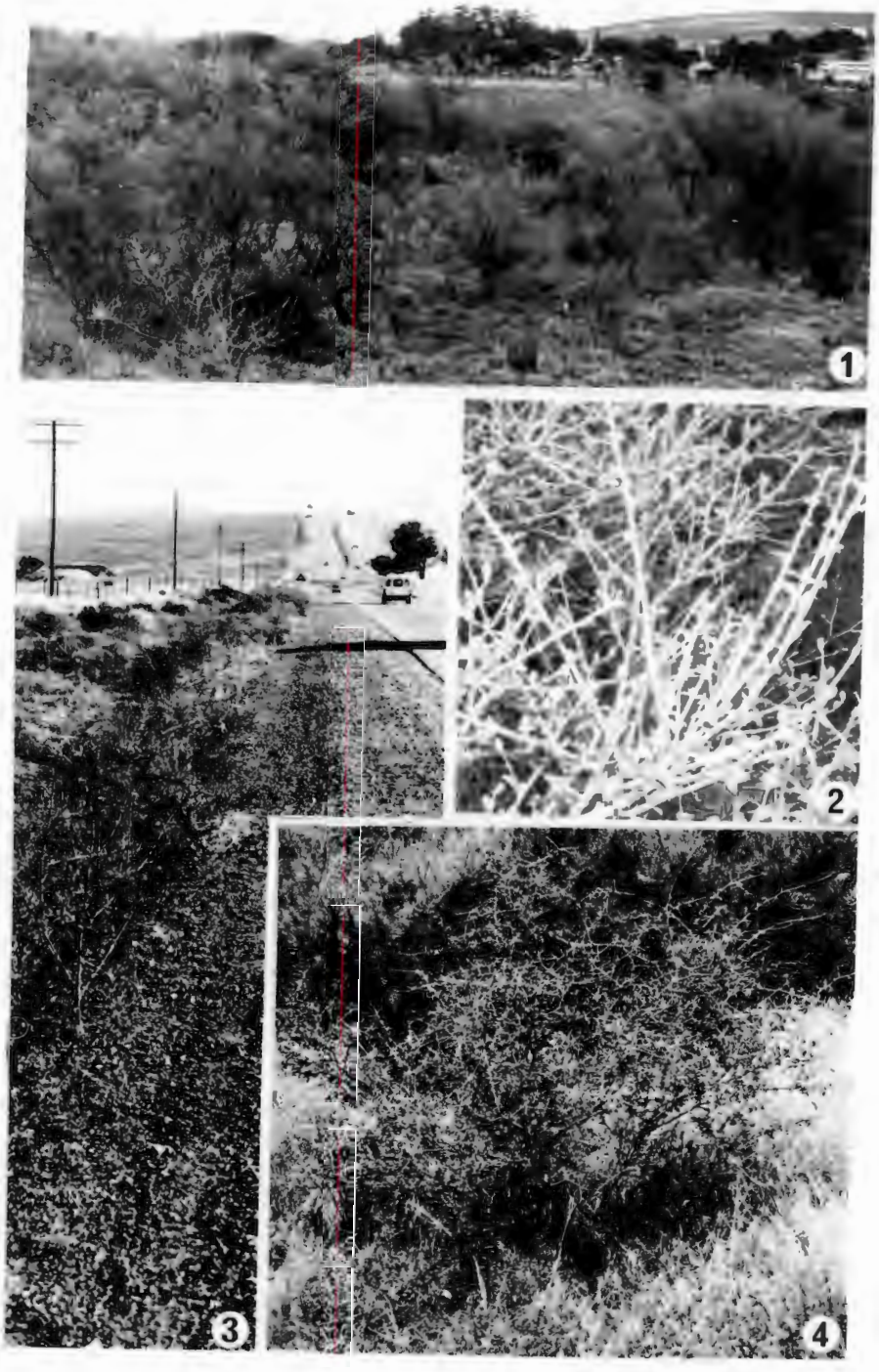


Fig. 9.4 *Otholobium hirtum*. 1, Dense stand of plants in a waste area between Stellenbosch and Kuils River (*Stirton 11135*); 2, Early season burs-branching typical of *O. hirtum*; 3, Roadside population between Moreesburg and Malmesbury (*Stirton 10204*); 4, Typical lax habit of plants of Leeurivier populations, between Wolsely and Tulbagh (*Stirton 10126*).

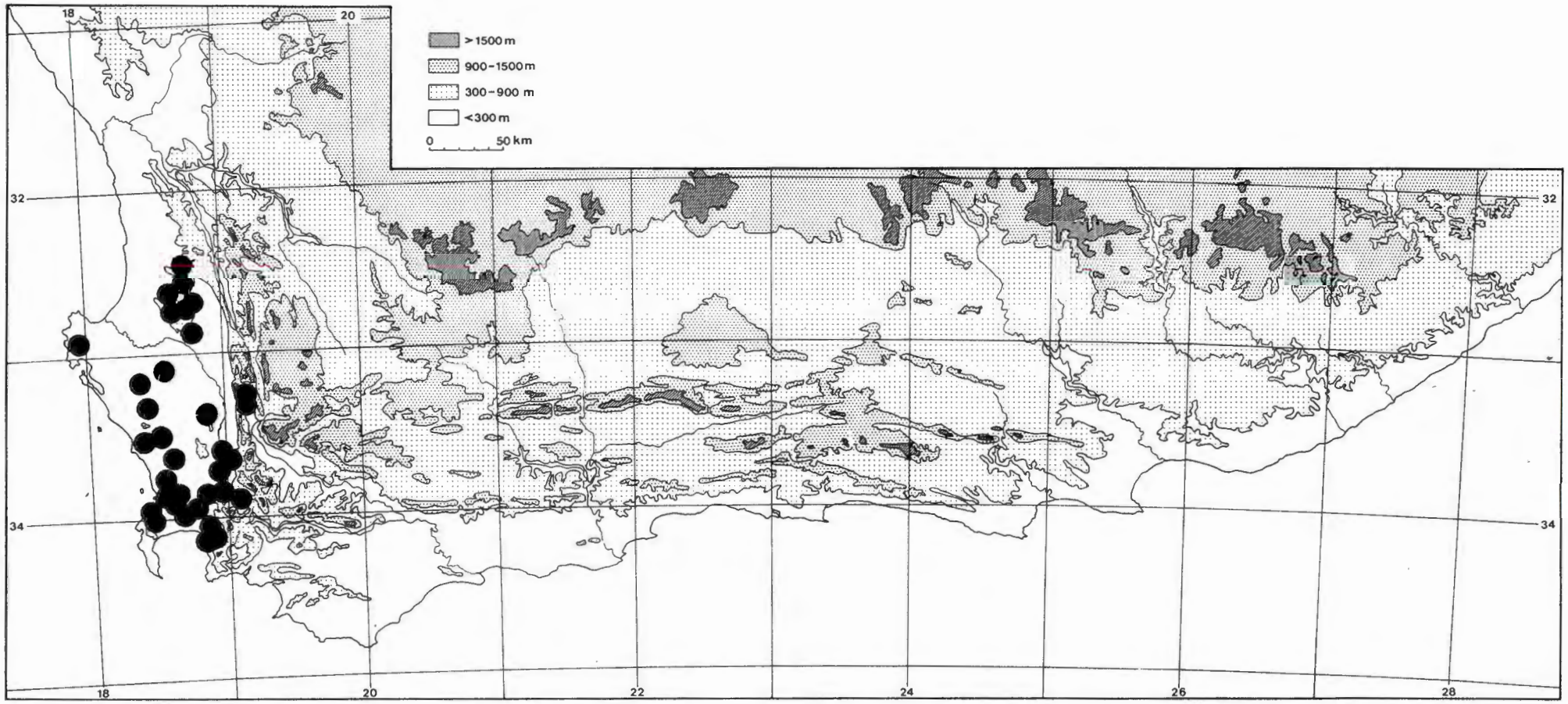


Fig. 9.5 Known distribution of *Otholobium hirtum* (L.) C.H. Stirton in southern Africa.

Fig. 9.6 *Otholobium hirtum*. (Piquetberg form) 1, Habit erect, much branched shrub with arcuate inflorescences; 2, Close up of brachyblasts showing dense pubescence and partially conduplicate strongly arching leaflets; 3, Fruiting calyces (*Stirton, Bean & Zantovska 11436*).

-3218 (Clanwilliam): Papkuil Vlei (--CB), 22-9-1940, *Bond 555* (NBG); Kapteinskloof (--DA), 20-10-1935, *Pillans 7816* (BOL, K); 30-8-1943, *Barker 2652* (NBG); 29-9-1943, *Barker 2977* (NBG); 4-11-1986, *Stirton, Bean & Zantovska 11407* (K, NBG); 2 km from Kapteinskloof to Aurora, 4-11-1986, *Stirton, Bean & Zantovska 11436* (K, NBG); NE base of Piquetberg (--DA), 23-10-1938, *Pillans 8634* (BOL); Het Kruis (--DA), 22-9-1940, *Bond 52* (NBG, PRE); Zebrakop (--DA), 13-10-1963, *Esterhuysen 30390* (BOL); near Sauer (--DC), *Leighton 125* (BOL); Piquetburg (--DD), 7-1910, *Bolus 7529* (BOL, K, PRE); 7-10-1892, *Bolus 3458* (NBG); 10-1892, *Guthrie 2595* (NBG); *Ecklon & Zeyher 1555* (BOL).

-3318 (Cape Town): between Mamre and Ysterfontein (--AD), 8-1931, *Bolus 21303* (BOL); Mud River Kloof (--AD), 29-10-1963, *Taylor 5493* (K, PRE, STE); Darling (--AD), 20-10-1952, *Godfrey 1236* (PRE, US); 30-10-1931, *Salter 1753* (K); 11-1948, *Van Breda 360* (PRE); farm Pampoenvlei, W of Contreberg (--AD), 18-10-1986, *Stirton 11204* (K, NBG); farm Groote Post, 18-10-1986, *Stirton 11200* (K, NBG); Mamre Hills (--BC), 12-10-1940, *Compton 9821* (NBG); 15 km from Moreesburg to Malmesbury (--BC), 5-12-1981, *Stirton 10204* (K, PRE); along main road from Malmesbury to Darling (--BC), 26-11-1960, *Van Breda 1034* (K, PRE); Riebeeck Kasteel (--BD), 18-10-1941, *Compton 12050* (BOL, NBG); farm Papkuilfontein (--BD), 12-1952, *Liebenberg 558c* (PRE, STE); Rosebank (--CD), 11-1878, *Bolus 2993* (K, BOL); Lions Head (--CD), 25-11-1941, *Compton 12552* (PRE); 1839, *Harvey* s.n. (K, MEL 1542100); 24-10-1938, *Penfold 167* (NBG); 10-1897, *Thode 6077* (STE); 13-12-1981, *Stirton 10377* (K, PRE); Koeberg road, 14 km from Cape Town (--CD), 11-1924, *Forbes* s.n. (BOL 18324); 10-1884, *Marloth 1584* (PRE); Newlands (--CD), 5-11-1943, *Salter 8790* (BOL); Rhodes Estate (--CD), 30-11-1980, *Stirton 8425* (K); 29-10-1913, *Peter 58* (K); Burgersfort, near Pella (--DA), 17-10-1979, *Boucher & Shepard 4832* (K, PRE); Koeberg (--DA), 7-10-1945, *Wasserfall 925* (K, PRE); Paarlberg (--DB), 3-1811, *Burchell 959* (K); 12-1830, *Drège* s.n. (G, K, SAM); 12-

1830, *Hennecart* s.n. (PRE 27012); Agter-Paarl (-DB), 14-10-1968, *Marsh 1074* (PRE); Wellington (--DB), 11-1881, *Thompson J.B. 56* (PRE); Tygerberg (-DC), 10-10-1975, *Loubser 3430* (MO); 31-10-1954, *Barker 8438* (BOL, NBG); Joostenburg farm, Bellville (--DC), 18-10-1961, *Barker 9611* (NBG); Langerverwacht, Kuils River (-DC), 21-10-1971, *Oliver 3697* (PRE, STE); 18-10-1986, *Goldblatt 7916* (MO, NBG, PRE, S, WAG); Stellenbosch (-DD), 10-1846, *Alexander Prior* s.n. (K); 3-11-1920, *Garside 1728* (K); 10-1912, *Worsdell* s.n. (K); Botmaskop (-DA), 22-9-1960, *Van Rensburg 462* (K, PRE, STE); 12-10-1960, *Van Rensburg 1988* (K, PRE, STE); Assegaibosch (-DD), 12-1969, *Van der Merwe 1319* (PRE); Ida's Valley (-DD), 7-11-1976, *Taylor 9536* (K, PRE, STE); 5 km from Stellenbosch to Kuils River (-DD), 14-1-1986, *Stirton 11135* (K).

-3319 (Worcester): Wintershoek Mountains (--AA), *Zeyher* s.n. (SAM 15419); Tulbagh (--AC), *Pappe* s.n. (K, MEL 1542096); Leeurivier, between Wolseley and Tulbagh (--AC), 4-12-1981, *Stirton 10126* (K, PRE); Fransche Hoek (--CC), 22-10-1846, *Alexander Prior* s.n. (K).

-3418 (Simonstown): near Sir Lowrys Pass (--BB), 10-1895, *Bolus 9195* (GRA, NH, PRE); 30-3-1815, *Burchell 8285* (K); Somerset West (--BB), 11-2-1942, *Parker 3650* (K, NBG); slopes above Three Anchor Bay (--BB), 20-10-1936, *Salter 6410* (BOL);

Without precise locality: Cape Flats, *Bolus 2993* (NBG); Cape, *Bowie* s.n. (K); Cape, *Burmann* s.n. (G); *Drege* s.n. (E, OXF); *Harvey* s.n. (K),*216* (E); 24-10-1937, *Martin & Thomas* s.n. (NBG); Hercules Pillar, 16-10-1938, *Penfold* s.n. (SAM 52913); *Scott-Elliott* s.n. (E); 1840, *Talbot* s.n. (K); Cape Peninsula, 10-1886, *Thode 9509* (STE); CBS, *Wawra 227* (W); Zwartland, *Zeyher* s.n. (MEL 1542125).

3. Otholobium rubicundum C.H. Stirton in Jl. S. Afr. Bot. 49: 337 (1983); Stirton in S. Afr. J. Bot. 52: 3 (1986). Type: Hoeko Road, south base of Klein Swartberg Mountains, *Wurts 1606* (NBG).

Shrub up to 1,5 m tall. **Stems** slender, ridged, waxy, sparingly covered with glands and small appressed white hairs. **Flowering shoots** axillary, appressed pubescent with numerous elliptic raised pustules. **Leaves** digitately trifoliate. **Stipules** 2,5 -- 3,5 mm long, 1,5 -- 2,0 mm wide, triangular, papery, sparingly pubescent but covered with orange-coloured, sunken, rounded glands. **Leaflets** 15 -- 25 mm long, 4 -- 6 mm wide, symmetrical, conduplicate, glabrescent, narrowly obovate, base cuneate, apex strongly recurved, mucronate; glands variously sized, more common and smaller on upper surface, impressed, drying black; laterals shorter than terminal leaflet. **Petioles** 2,0 -- 2,5 mm long, hairy. **Inflorescence** axillary, condensed, comprised of 1 -- 2 sets of triplet flowers; each set subtended by a single 3 mm long, 1,5 mm wide narrowly obovate, acute, hairy and glandular bract; peduncle 1 -- 2 mm long. **Flowers** 9 -- 10 mm long, pink; pedicel 2 mm long; flower bracts variabe, 1 -- 2 mm long, oblong to triangular. **Calyx** 7 mm long; teeth equal, margins densely ciliate, 4 mm long, upper four teeth 1,7 mm wide, keel tooth 3 mm wide, vexillar teeth fused above tube for about half their length; lobes prominently glandular, glabrous inside and outside except for a few hairs along the ribs; tube 3 mm deep, ribbed. **Standard** 12 mm long, 8 mm wide, broadly ovate, scarcely auriculate, appendages absent; claw 4 mm long. **Wing petals** 10 -- 11 mm long, 3 mm wide, auricle 1 mm high; sculpturing upper basal and left central comprised of 35 -- 40 parallel transcostal lamellae. **Keel blades** 7 mm long, 3 mm wide, blade convex, claw 3,5 mm long. **Androecium** 7 mm long; vexillar stamen fused to sheath for more than half its length. **Pistil** 5,5 mm long; ovary 1,5 mm long, glandular with few hairs, gynophore absent; style glabrous, broadest at point of flexure, height of curvature 1,5 mm; stigma minutely capitate, finely penicillate. **Fruit** and seed unknown. Fig. 9.8.

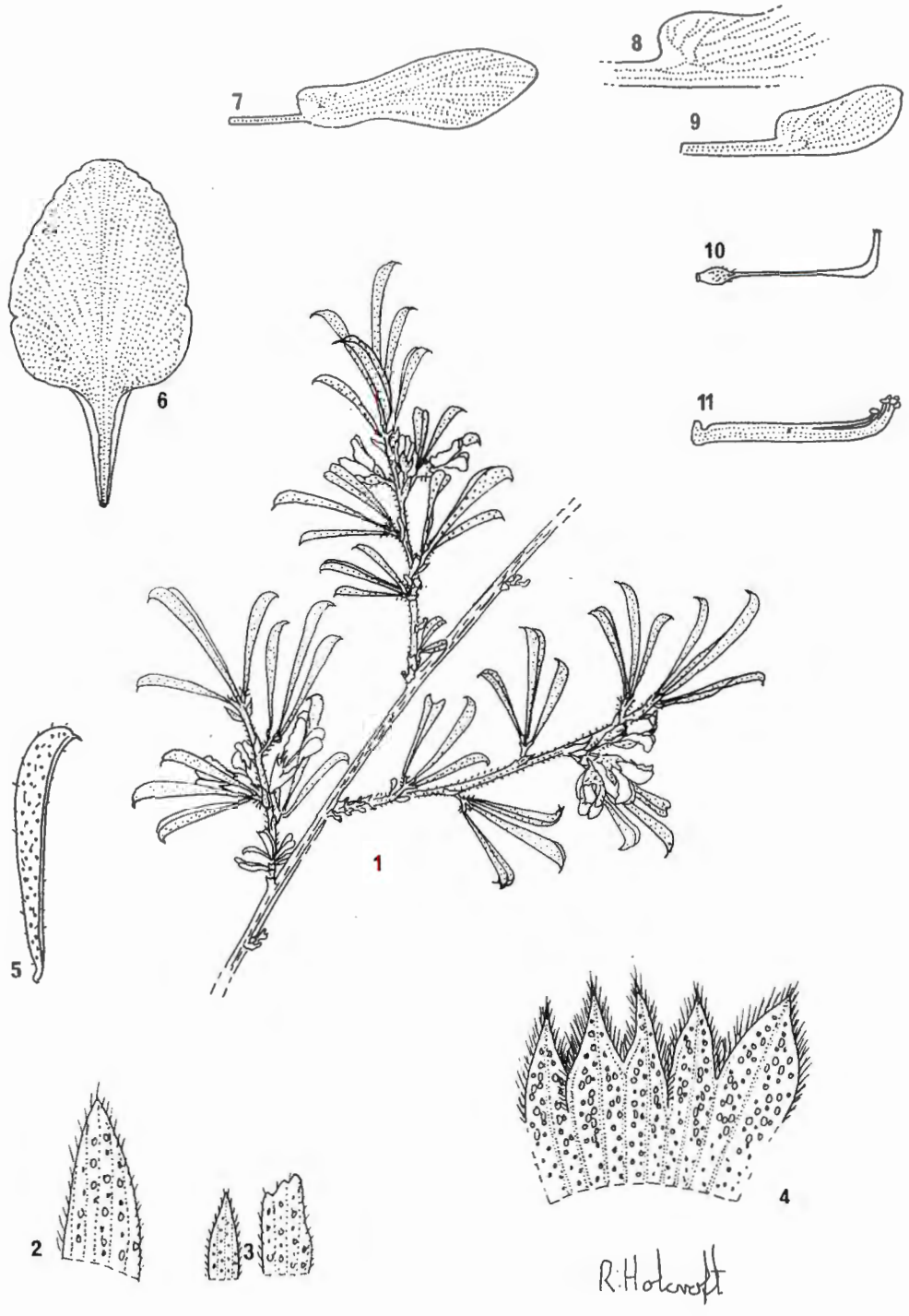


Fig. 9.8 *Otholobium rubicundum*. 1, Flowering branches, x1; 2, Stipule, x4; 3, Triplet bracts, x4; 4, Calyx opened out, inner face, x4; 5, Terminal leaflet, x4; 5, Standard, x4; 6, Standard, x5; 7, Wing petal, x4; 8, Auricle region of wing petal, x16; 9, Keel petal, x4; 10 Pistil, x4; 11, Androecium, x4 (*Wurtz 1606*).

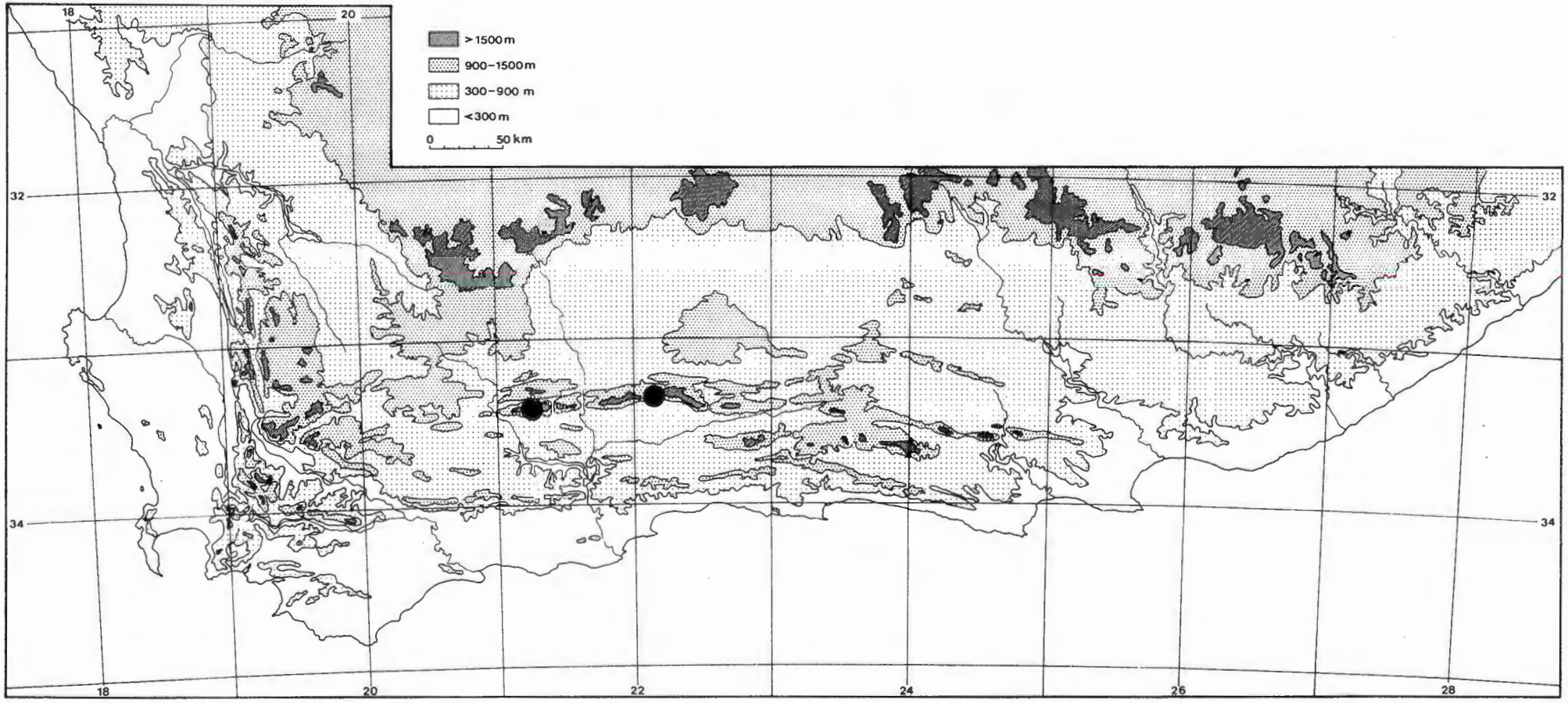


Fig. 9.9 Known distribution of *Otholobium rubicundum* C.H. Stirton in southern Africa.

Otholobium rubicundum (Fig. 9.9) was first found by Mr Jan B. Gillett near the Cango Caves. The second collection, by T.M. Wurts was made in 1957 at an altitude of about 650 m, apparently in the transition belt between False Macchia and Succulent Mountain Scrub vegetation types. The Moffett collection was found among *Elytropappus rhinocerotis* and *Dodonaea angustifolia* in a transition between sandstone talus and limestone. Apart from the knowledge that flowering takes place during late October and early November little else is known about the biology of this rare and distinctive shrub. The Bond collection refers to its occurrence in Waboomveld (*Protea nitida*) on steep southern slopes. It occurs between 600 -- 1000 m in altitude.

O. rubicundum has been confused in the past with *O. racemosum* but it is easily distinguished from that species by its few-flowered scarcely pedunculate inflorescences and pink flowers. *O. rubicundum* is characterised by a combination of characters: small spreading shrublet; leaflets conduplicate, inflorescence 3 -- 6 flowered, condensed; flowers pink, each triplet subtended by a narrowly obovate acute bract; standard broadly ovate.

Specimens examined

- 3321 (Ladismith): Hoeko Road, south base of Klein Swartberg (--AD), 10-1957, *Wurts 1606* (NBG); Cango Caves (--BD), 16-10-1928, *Gillett 1674* (BOL, STE).

-3322 (Oudtshoorn): Bassonsrus Farm, Cango Valley (--AC), 3-11-1974, *Moffett 362* (PRE, STE); Stefaanskop, 29-10-1980, *Bond 1819* (SAAS).

4. Otholobium hamatum (Harv.) C.H. Stirton in S. Afr. J. Bot. 52: 3 (1986).

P. hamata Harv. in Harv. & Sond., Fl. Cap. 2. 152 (1862) non sensu Forbes (1930). Holotype: "Roodeberg", *Drege* s.n. (G, K,). The specimen in K bears Harvey's determinavit slip. I have not come across any other sheets with Harvey's writing so I presume that this is the holotype. Some authors, eg. E. Mey., Comm. 87 (1836), have confused this species with *Psoralea racemosa* Thunb.

Erect, densely leafy shrub up to 1,5 m tall, spreading. **Branches** striate, subcanescent, becoming glabrous; twigs slender, canescent, densely pustulate. **Leaves** digitately trifoliolate, sub-sessile, stipulate. **Leaflets** (8) 10 -- 13 mm long, 4 -- 7 mm wide, symmetrical, complicate, obovate, base obtuse, apex emarginate; hispidulous below, dark green and nitid above, glabrous, prominently glandular, more glands on upper surface, glands drying black; petiole <1,5 mm long; petiolules 1 mm long, canescent. **Stipules** 2,0 -- 2,5 mm long, clasping, longer than petioles, subulate, persistent. **Inflorescences** terminal on shoots up to 15 cm long, laxly spicate, flowers subalternate; comprised of 6 -- 7 (10) triplets of subsessile flowers, each triplet subtended by a caducous 2,0 -- 2,5 mm long broadly elliptic-oblong bract; peduncle 10 -- 30 mm long. **Flowers** 7 -- 8 mm long, ebracteate, white; pedicel <1 mm long. **Calyx teeth** slightly longer than the tube, subequal, lanceolate; carinal lobe broader and longer than the other teeth, 6 --7 mm long, 1,5 mm wide, vexillar teeth fused for more than half their length, appressedly puberulous; glands all over, variously sized. **Standard** 8 -- 9 mm long, 5 -- 6 mm wide, claw 2 mm long, broadly elliptic, apex broadly emarginate, shortly auriculate. **Wing petals** 8 -- 9 mm long, 2 mm wide, claw 3,5 -- 4,0 mm long; sculpturing upper central, comprised of (18) 20 -- 25 transcoastal lamellae, rows irregular. **Keel petals** 6,0 -- 6,5 mm long, 2,0 mm wide, claw 3,0 -- 3,5 mm long; shorter than wing petals. **Androecium** 6,0 -- 6,5 mm long, sheath split adaxially, vexillar stamen lightly adherent to lower third on left side of split; anthers equal. **Pistil** 6 mm long; ovary 2 mm long, raised on a flange of

Fig. 9.10 *Otholobium hamatum*. 1, Flowering shoots, x1; 2, Digitately trifoliolate leaflet, x4; 3, Side view of flower, x4; 4, Standard, inner face, x6; 5, Wing petal, x6; 6, Keel petal, x6; 7, Pistil, x7; 8, Calyx opened out, x6; 9, Triplet bract, x9 (*Taylor 5526*).

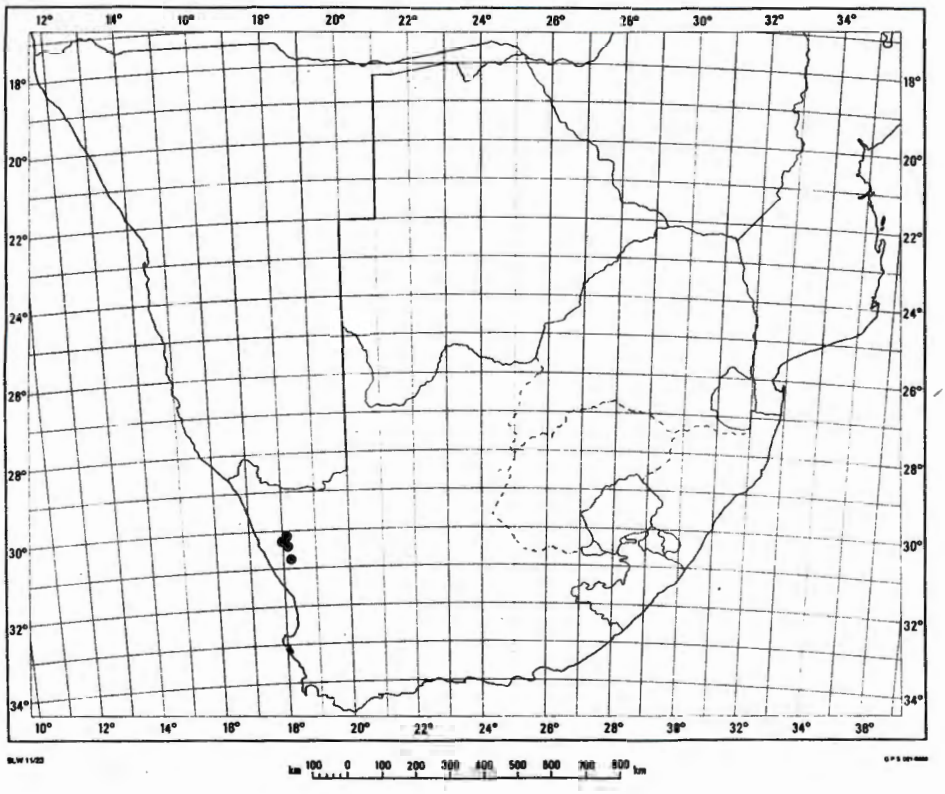


Fig. 9.11 Known distribution of *Otholobium hamatum* (Harv.) C.H. Stirton in southern Africa.

upright tissue, pilose towards apex; height of curvature 1,0 -- 1,5 mm, mostly thickened at point of curvature; stigma penicillate. **Fruits** and seeds unknown. Fig. 9.10.

O. hamatum is endemic to areas of Mountain Renosterveld (Acocks's Veld Type 43) on the Kamiesberg Mountains (Fig. 9.11). Flowering takes place in November and December. It occurs between 1000 -- 1600 m altitude.

O. hamatum is most closely related to *O. pustulatum* and *O. flexuosum* but differs from these species in its densely pustulate stems, leaves and calyces and hispidulous leaves. It differs from *O. pustulatum* in its erect spreading habit, densely leafy branches, complicate leaves and subulate persistent stipules. *O. pustulatum* has a tangled habit, laxly leafy branches, flat sparsely sericeous leaves and setaceous caducous stipules. From *O. flexuosum* it differs in its trifoliolate leaves and straight inflorescences. *O. flexuosum* has digitately trifoliolate leaves and flexuous inflorescences.

Specimens examined

-3017 (Hondeklipbaai): Kamiesberg (--BB), 12-12-1910, *Pearson 5864* (K).

-3018 (Kamiesberg): Roodeberg & Ezelskop (--AA), *Drege* s.n. (G, K, OXF); east Kamiesberg, 3 km north of Welcome Farm (--AC), 4-11-1982, *Rourke 1795* (K, NBG, PRE); Kamiesberg, Namaqualand (--AC), 3-11-1963, *Taylor 5526* (PRE, STE).

Without precise locality: Cape, *Drège 321* (W); 19-12-1936, *Adamson 1504* (BOL).

5. Otholobium candicans (Eckl. & Zeyh.) C.H. Stirton in S. Afr. J. Bot. 52: 2 (1986).

Psoralea candicans Eckl. & Zeyh., Enum. 228 (1836); Walpers, Repert. 1: 657 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 150 (1862); Forbes in Bothalia 3: 122 (1930); Bohnen, Flow. Fl. S. Cape 33, t. 43. 2 (1986). Lectotype: "in lapidosis (Altit. II) in Karoo prope flumen Gauritzrivier (Swellendam)", *Zeyher* s.n. (S, lecto; G, K, L, MO, S, SAM, iso). I have discovered only four sheets which bear the collector's distribution label. None of the sheets bear labels in the collector's hand. All the sheets have more than one twig present except for the S sheet which I have designated the lectotype.

P. hirta Thunb., Fl. Cap 609 (1823) pro parte non L. (1753).
Lectotype: "e Cap. Bon. Spei", *Thunberg* s.n. (UPS - Thunb. left hand specimen 17573).

P. hirta L. sensu Eckl. & Zeyh., Enum. 228 (1836).

Robust, much branched, spreading to erect shrub with virgate seasonal shoots. **Branches** rarnulous, canescent, laxly leafy. **Leaves** digitately trifoliolate, shortly petiolate. **Leaflets** 10 -- 20 mm long, 3 --4 mm wide, narrowly obovate, recurved mucronate, mucro weak; apex emarginate, base cuneate; conduplicate; thick, veins and glands scarcely visible or sometimes distinctly nigro-punctate, surfaces minutely puberulous or glabrescent with age; petiole 1,0 -- 1,5 mm long; petiolules 0,2 -- 0,3 mm long. **Stipules** 2 -- 3 mm long, narrowly triangular, clasping, persistent. **Inflorescences** axillary, often crowded in an interrupted spurious raceme, subsessile or pedunculate up to 3 cm; comprised of 1 -- 3 triplets of distinctly pedicellate flowers, each triplet subtended by a triangular glandular 3 mm long bract; caducous. **Flowers** 8 -- 10 mm long, ebracteate, lilac; pedicel 3 --

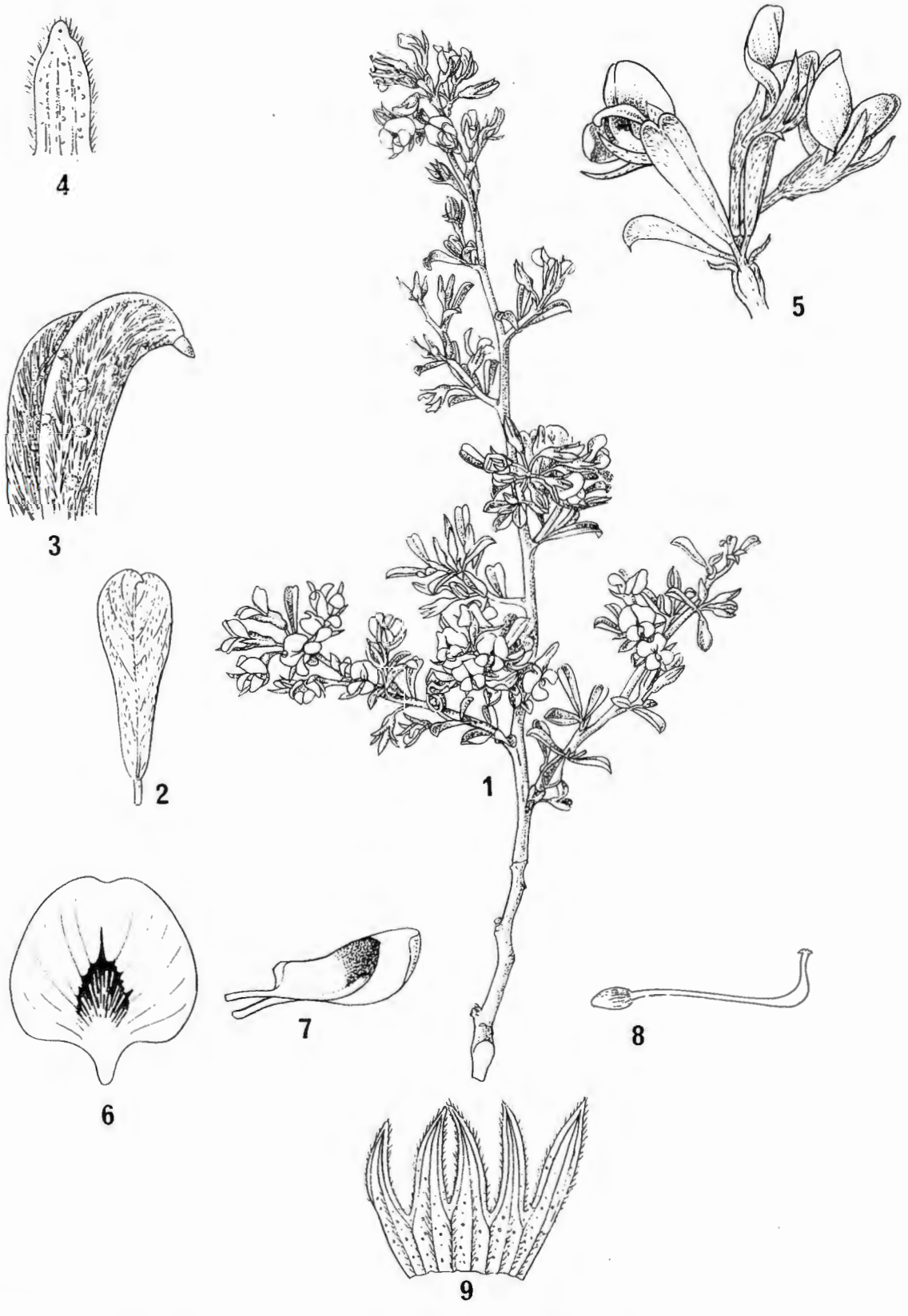


Fig. 9.12 *Otholobium candicans*. 1, Flowering branch, x1; 2, Terminal leaflet, x2; 3, Apex of terminal leaflet, x6,5; 4, Stipule, x10; 5, Inflorescence, x3; 6, Standard, x6; 7, Keel and wing petals, x7; 8, Pistil, x8; 9, Calyx opened out, outer face, x6 (*Stirton 11283*).

4 mm long. **Calyx teeth** 3 -- 4 times longer than the purple-tinged tube, equal, slightly falcate to straight, linear-lanceolate, taper-pointed, carinal tooth broadest; lobes 4 -- 8 mm long, < 1 mm wide, vexillar lobes fused for 1 -- 2 mm above the tube; glabrous to densely white sericeous, glands evenly dispersed on teeth and tube, sometimes impunctate; characteristically accrescent in fruit, lobes patently upcurving and glabrous, fruit clearly visible. **Standard** 6 mm long, 5 mm wide, lilac, nectar patch reddish violet with two purple spotted white areas on either side, apex obtuse to rounded, claw short, 1 mm long, auricles scarcely developed. **Wing petals** longer than keel petals, fused to them near the auricle, 6,0 --7,0 mm long, 1,5 -- 2,0 mm wide, claw 3 mm long; blade upcurving, distal portion folded inwards; sculpturing upper basal and upper central, comprising 25 -- 40 transcostal lamellae. **Keel petals** 4,5 -- 5,0 mm long, 1,5 -- 2,0 mm wide, apex acute, claw 2 mm long. **Androecium** 4,5 -- 5,0 mm long, pseudomonadelphous, sheath flared at base, fenestrate. **Pistil** 4,0 -- 4,5 mm long; ovary 1 mm long, shaggy; height of curvature 2 mm, entasis well-developed at or before point of flexure, style sparsely hairy between ovary and entasis; stigma capitate, penicillate. **Fruits** 3 -- 4 mm long, papery, finely pubescent. **Seeds** 3,5 -- 4,0 mm long, chestnut brown. Fig. 9.12.

Otholobium candicans is a widespread variable species (Fig. 9.14) exhibiting a number of clines of pubescence, leaf size, glandulosity and habit. The species needs to be further studied in the field. It is possible that the most north-westerly populations could represent a different taxon compared to the eastern Cape plants which are more slender and taller. There are a number of collections centred around Paardeberg (*Stokoe, SAM 55823*), Tulbagh (*Bolus 5040)*, Artois (*Stirton 8446*) and Bontebok National Park (*Acocks 22915*) which differ in their broader nigropunctate leaflets, sessile more floriferous inflorescences, densely sericeous calyces and compact habit, which might constitute a different taxon.

Fig. 9.13 *Otholobium candicans*. 1, Season shoots from coppice; 2, Short flowering shoots, note distinctive recurved-mucronate leaf tips; 3, Diffuse sprawling much branched habit, with inset showing autapomorphic displayed calyces (*Stirton 10332*).

O. candicans is closest to *O. spissum* and is distinguished by its virgate habit, narrower minutely puberulous to glabrescent leaflets with scarcely discernible glands, poorly developed mucro, ebracteate flowers and chestnut coloured flowers. *O. spissum* by contrast is a much-branched woody shrub with broader dark green nitid glabrous leaves bearing many clearly visible glands and with a distinct mucro, with tufted flower bracts and khaki-green and brown blotched seeds.

Little is known about the ecological preferences of this species except that it is asssociated with rocky outcrops on mountainsides. It occurs between 120 and 600 m altitude. Flowering takes place from August to December reaching a peak in October.

Specimens examined

-3225 (Somerset East): Bruintjieshoogte (--CB), 12-1856, *Macowan 1856* (K, PRE).

-3319 (Worcester): New Kloof, Tulbagh (--AC), 18-10-1941, *Barker 2374* (PRE); Tulbagh (--AC), *Ecklon* s.n. (MEL 1542103, SAM 15414); along roadside near Karoo Poort (--BA), 29-11-1908, *Pearson 4805* (BOL, K, STE); Hex River Valley near De Doorns (--BC), 30-10-1974, *Goldblatt 3203* (MO); 1-10-1893, *Bolus 3056* (NBG); 10-1893, *Tyson 3104* (SAM); between Hottentots Kloof and Karoo Poort (--BC), 29-11-1908, *Pearson 4811* (K); Bokkeveld Flats (--BC), 10-1923, *Levyns & Levyns 527* (STE); Rabiesberg, Worcester (--CA), 26-9-1935, *Compton 5823* (BOL); 27-9-1935, *Lewis* s.n. (BOL 32219); Karoo Gardens (--CB), 26-9-1953, *Compton 24365* (STE); Worcester (--CB), 28-10-1948, *Liebenberg 4200* (PRE); 14-11-1962, *Olivier 207* (PRE); Langeberge, Robertson (--DB), *Nel* s.n. (STE 19608); Karoo Koppie, Robertson (--DD), 9-1934, *Kuum* s.n. (STE 19611).

-3320 (Montagu): 22 km from Montagu to Barrydale (--CA), 26-10-1986, *Stirton & Zantovska 11283* (K, NBG); Klipbokkraal (--CC), 26-10-1961, *Van Breda 1494* (PRE); 55 km

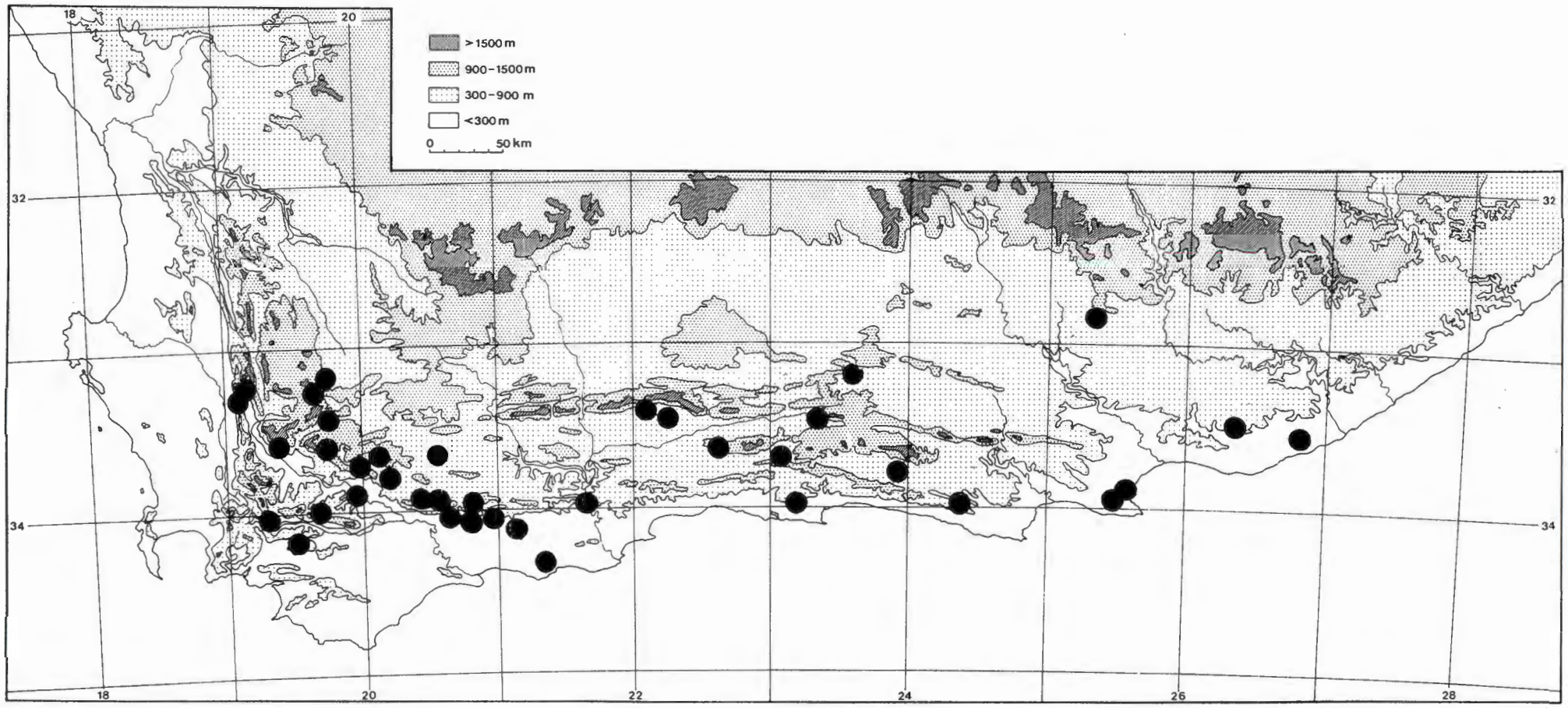


Fig. 9.14 Known distribution of *Otholobium candicans* (Eckl. & Zeyh.) C.H. Stirton in southern Africa.

from Montagu to Barrydale (--CD), 26-10-1986, *Stirton & Zantovska 11282* (K, NBG); Ruggens, Zuurbraaks (--DC), 11-9-1897, *Galpin 3960* (PRE).

-3321 (Ladismith): in Karoo near Gauritzrivier (-DC), *Zeyher* s.n. (K, S, SAM, W).

-3322 (Oudtshoorn): between Kliphuisvlei and Die Hell (--AC), 2-3-1986, *Goldblatt 7993* (MO); Swartberg Pass (--AC), 4-10-1974, *Goldblatt 2964* (MO, NBG, PRE); 2 km from Cango Caves to Swartberg Pass (--AC), 12-12-1981, *Stirton 10332* (K, PRE), *11565* (K); Kamanassie Mountain (--DA), *Vlok 1153* (K, GRA, NBG, PRE, SAAS).

-3323 (Willowmore): Jonkkrans, Lang Kloof (--CA), 14-5-1974, *Bayliss 844* (PRE); Grootfontein farm, between Uniondale and Buffelsdrift (--CA), 3-10-1971, *Coppejans 1355* (U); north banks of Kouga River at drift on road to Brand Hoek (--DD), 10-1933, *Fourcade 5104* (BOL, K, PRE, STE).

-3324 (Steytlerville): on branch road to de Jager's farm, Suur Anys (--CD), 9-1925, *Fourcade 3046* (BOL, PRE, STE).

-3325 (Port Elizabeth): Villa Paul Mare (--CD), *Zeyher* s.n. (MEL 1542102, SAM 49212); Redhouse (--DC); 10-1908, *Paterson 238* (K, GRA); Zwartkopsrivier (--DC), *Zeyher* s.n. (G, K, SAM 49210, TUB, W).

-3326 (Grahamstown): Albany farm near Grahamstown (--BC), 11-1928, *Dyer 1734* (GRA); Aylesbury (--BC), 20–1–1928, *Hutchinson 1593* (K, PRE); Bathurst (--DB), 10-1963, *Sidey 3823* (PRE, US).

-3419 (Caledon): Caledon School (--AB), 1826, *Mund 42* (K, SAM 49207); Elandskloof (--AB), 16-12-1896, *Schlechter 1460* (BOL, G, K, PRE, W); Ruggens near Genadendal (--BA), 10-1897, *Galpin 3959* (GRA, PRE).

-3420 (Bredasdorp): Hassaquaskloof (--AA), *Ecklon & Zeyher* s.n. (MEL 1541963, SAM 49211, OXF, W); north of Heidelberg (--BB), 21-10-1986, *Goldblatt 7955* (MO); Bontebok National Park (--CA), 7-11-1962, *Acocks 22915* (K, PRE, STE); Buffeljagsdam (--BA), 10-1975, *Van Der Merwe 2655* (PRE).

-3421 (Riversdale): Kransfontein farm, Stillbay (--AD), 7-10-1980, *Bohnen 7742* (PRE); Klipfontein Farm, Kafferskuilvallei (--AD), 30-9-1983, *Bohnen 8332* (STE).

Without precise locality: Kerkelbosch, 7-11-1954, *Archibald 5657* (BOL, G, K, PRE); CBS, *Boivin* s.n. (P, PRE); Cap., *Burmann* s.n. (G); Landina, 5-11-1941, *Esterhuysen 7609* (BOL, K, PRE); *Reuter* s.n. (G); veld reserve, 7-1937, *Van Breda 48* (PRE); C.B.S., 1831, *Verreaux* s.n. (G).

6. Otholobium spissum C.H. Stirton, *sp. nov., O. candicans affinis sed habitu denso multi ramosa lignoso, floribus paucis albis calycibus atropubescentibus dentibus vexillaribus calycis falcata ovario dense sericeo differt.*

Typus: 3320 (Montagu): 55 km from Montagu to Barrydale (--CD), 26-10-1986, *Stirton & Zantovska 11281* (NBG, holo; K, iso).

Frutex densus multiramosus lignosus usque 1,5 m altus. Rami griseo-brunnei, lenticellis albis densis juventute appresse albo pubescentes. Folia digitatum trifoliolata, petiolata. Foliola (7) 8 -- 9 (11) mm longa, 4 -- 6 mm lata, obovata; recurvato-mucronata, mucrone abrupte recurvata, apice emarginata base cuneata conduplicata margine laevi, glabra, hebeto-virida; petiolus 1,0 -- 1,5 mm longus, pubescens. Stipulae quam petiolus breviores, subulatae, persistentes, rectae. Inflorescentiae ex axilibus superioribus ramulorum brevium annuorum orientes floribus in grego triflora a bractea parva oblonga senescenti subtenta aggregatis. Flores 5 -- 6 mm longi omnes a caespite minuto pilorum subtenti, albi, pedicello 2 mm longo. Dentes calyces quam tubus 2,5 mm longus longiores, aequales, lanceolati, falcati, dente carinali quam aliis aliquantum latiore; lobi 5 -- 6 mm longi, 0,5 -- 2,0 mm lati, vexillaribus ultra tubo non connatis; purpureo-suffusi, pilis brevibus atris saepe appressis sparsim obtecti. Calyx ubique glandulosus dentibus magis glandulosis; in fructu accrescens. Vexillum 6,0 -- 7,0 mm longum, 6,5 mm latum, album, latissime obovatum, apice emarginatum. Alae 6,0 -- 6,5 mm longae, 2 mm latae quam carina longiores. Petala carinae 4,0 -- 4,5 mm longa, 2 mm lata. Androecium 5 mm longum, pseudomonadelphum, fenestratum. Pistillum 4,0 -- 4,5 mm longum; ovarium 1,5 mm longum dense sericeum, parte curvata 1,5 mm alta, entase ad parte flexuosa bene evolutus; stigma penicillatum, incurvatum. Fructus seminaque ignoti.

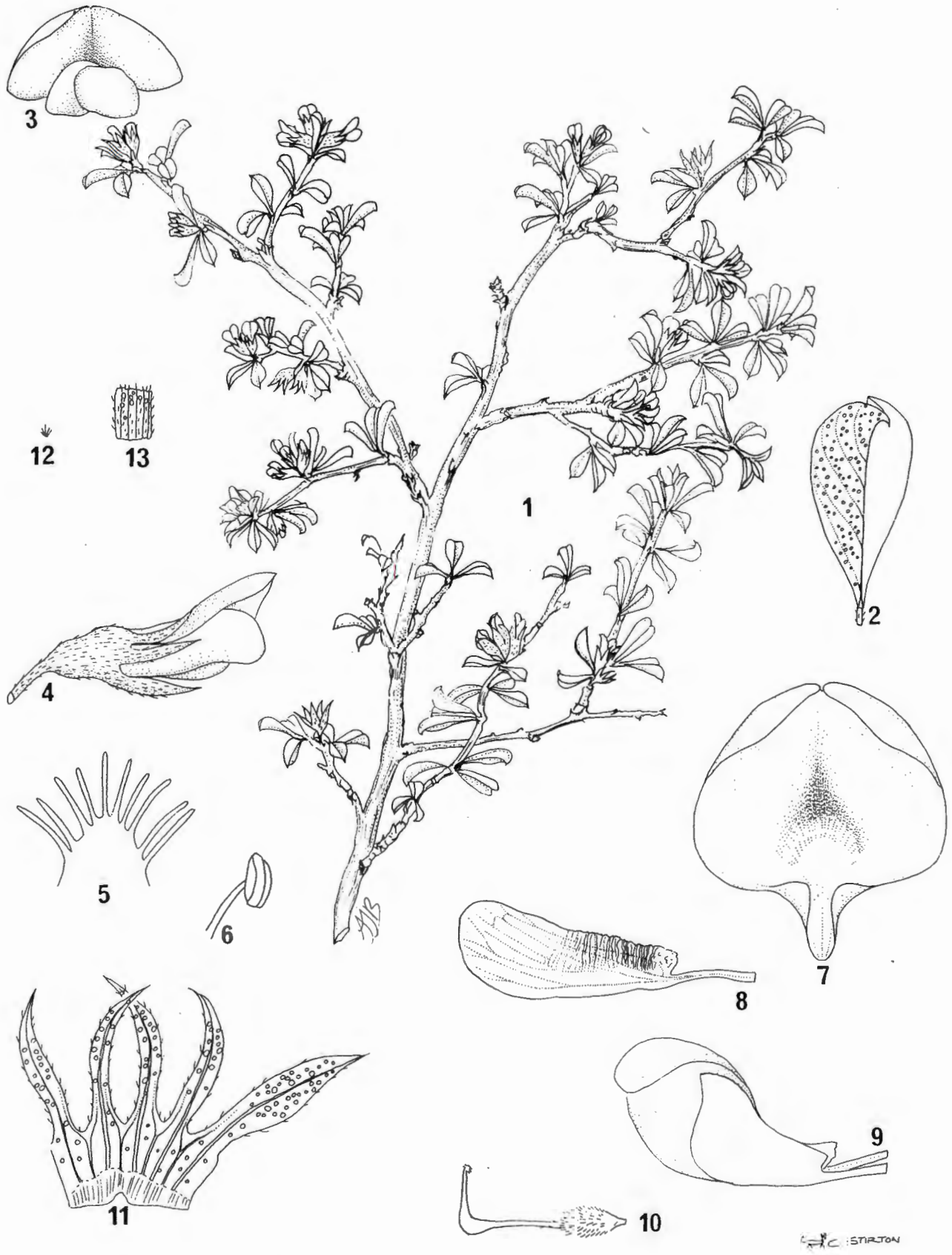


Fig. 9.15 *Otholobium spissum*. 1, Flowering branches, x1; 2, Terminal leaflet of digitately trifoliolate leaflet, x4; 3, Face view of flower, x10; 4, Side view of flower, x10; 5, Free upper part of filaments of androecial sheath, x25; 6, Anther x30; 7, Standard, x11; 8, Wing petals, x8; 9, Keel petals and wing petals, x8; 10, Pistil, x7; 11, Calyx opened out, inner face, x8 (1, *Stirton 11281*; 2-11, *Van der Merwe 2831*).

Dense, much branched, tangled, woody shrub up to 1,5 m high. **Branches** greyish-brown, lenticels white and dense, appressed white pubescent when young. **Leaves** digitately trifoliolate, petiolate. **Leaflets** (7)8 -- 9(11) mm long, 4 -- 6 mm wide, obovate; recurved-mucronate, mucro sharply recurved; apex emarginate, base cuneate, conduplicate, margin smooth; glabrous, dull green; petiole 1,0 -- 1,5 mm long, pubescent. **Stipules** 20 -- 25 mm long, shorter than petiole, subulate, persistent, straight. **Inflorescences** axillary in upper axils of short seasonal shoots, comprised of a triplet of pedicellate flowers and subtended by a small oblong senescent bract. **Flowers** 5 -- 6 mm long, each subtended by a minute tuft of hairs; white; pedicel 2 mm long. **Calyx teeth** longer than the 2,5 mm long tube, equal, lanceolate, falcate, carinal tooth somewhat broader than the other teeth; lobes 5 --6 mm long, 0,5 -- 2,0 mm wide, vexillar lobes not fused above the tube; tinged purple, sparsely covered in short appressed black hairs, glandular over entire surface, more so on teeth; accrescent in fruit. **Standard** 6,0 -- 7,0 mm long, 6,5 mm wide, white, very broadly obovate, apex emarginate, claw 2 mm long, auriculate. **Wing petals** 6,0 -- 6,5 mm long, 2 mm wide, claw 2 mm long, longer than petals; auricle well-developed, puckered; sculpturing upper central and upper basal, comprised of 40 -- 55 transcostal lamellae, lamellae distinct, especially near the auricle. **Keel petals** 4,0 -- 4,5 mm long, 2 mm wide, claw 2 mm long, bulge well-developed. **Androecium** 5 mm long, pseudomonadelphous, fenestrate. **Pistil** 4,0 -- 4,5 mm long; ovary 1,5 mm long, densely sericeous; height of curvature 1,5 mm long, entasis broadest at point of flexure; stigma penicillate, incurving. **Fruits** and seeds unknown. Fig. 9. 15.

Otholobium spissum is found in Central Mountain Renosterveld on Bokkeveld and Witteberg shales (Fig. 9.16). It occurs as occasional individual plants. Flowering takes place in July and August.

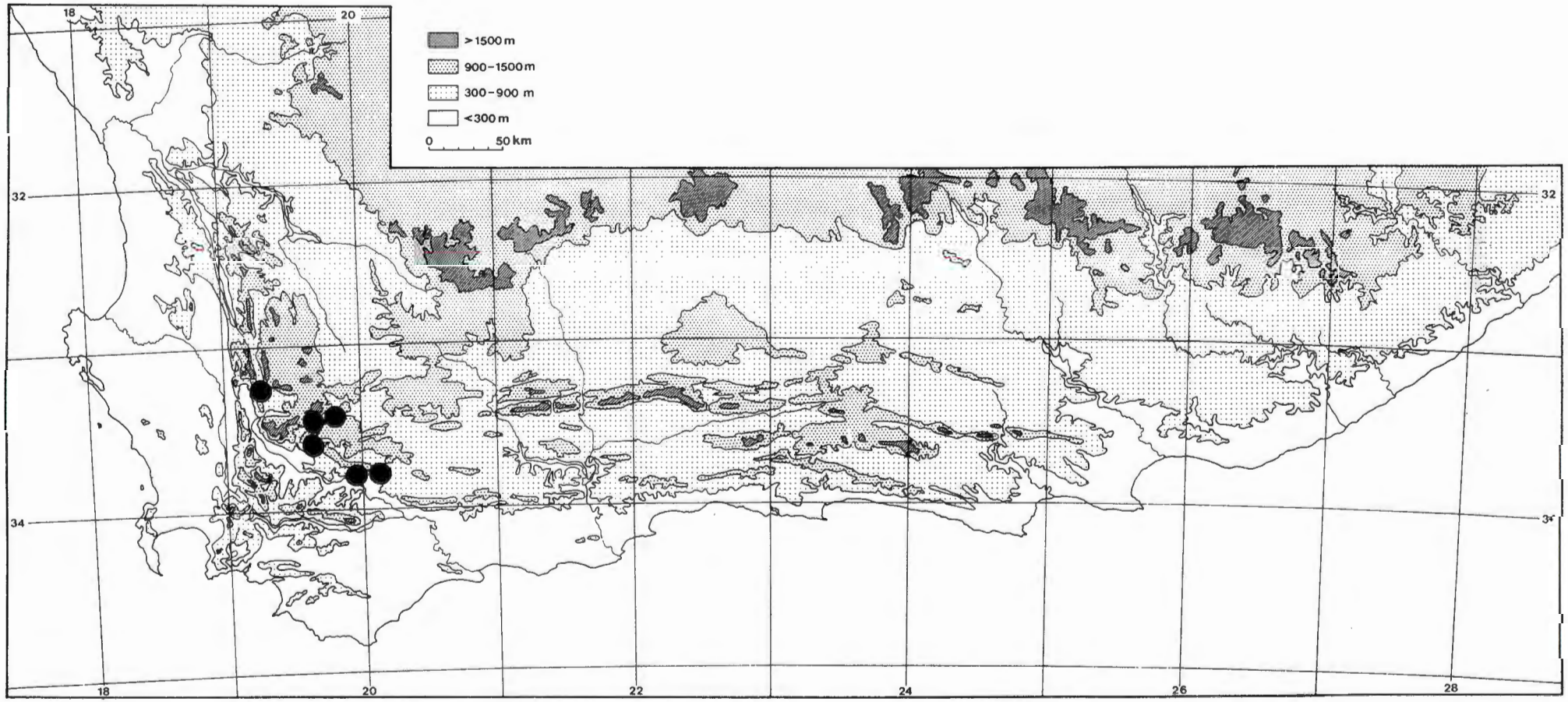


Fig. 9.16 Known distribution of *Otholobium spissum* C.H. Stirton in southern Africa.

O. spissum is characterised by its densely branched, compact woody habit, retention of the previous season's short shoots, small white flowers, black-haired calyces, densely sericeous ovary and falcate vexillar calyx teeth.

Specimens examined

-3320 (Montagu): Kogmans Kloof (--CC), 31-7-1952, *de Wet* s.n. (BOL 25068); 55 km from Montagu to Barrydale (--CD), 26-10-1986, *Stirton & Zantovska 11281* (K, NBG); Janbastersкloof (--DC), 21-11-1980, *Stirton 8259* (E, K, NBG).

-3319 (Worcester): near De Doorns, Hex River (--AC), 10-1907, *Bolus 8005* (BOL, K, PRE, SAM); Tulbagh Kloof (--AC), 18-10-1986, *Goldblatt 7927* (K, MO, PRE); between Sandhills and Orchard (--BB), 28-9-1978, *Esterhuysen 35047* (BOL, K); mountains above Worcester (--BB), *Rehmann 2435* (K); Vrojlikheid Nature Reserve (--DD), 7-1972, *Van der Merwe 2831* (PRE).

Without precise locality: *Van Breda 575* (PRE).

7. Otholobium sabulosum C.H. Stirton, sp. nov.

Typus: Hills north of De Hoop Vlei, 25-9-1973, *Esterhuysen 33240a* (BOL, holo.; K, iso.).

Frutex nanus prostratus usque 5 cm altus. Caules multi prope basin ramosi, ramulos numerosos ascendentes annuos usque 15 cm longos efferentes; apprese puberuli, purpureo-brunnei. Folia digitatim trifoliolata, patentia, vix petiolata. Foliola inequales, terminale 7 -- 12 mm longo, 5 -- 7 mm lato, obovato; lateralibus minoribus symetricis; folia persistenta quam annua maiora; basi cuneata, apice acuminata, mucrone recto 1 mm longo; juventute glabra, marginibus sparsim pilosa, glabrescentia, glandulis superne impressis inferne elevatus minus manifestis; petiolus <2 mm longus; petioluli <1 mm longi. Stipulae 3,0 -- 3,5 mm longae, lanceolatae. Inflorescentia in ramulis brevibus annuis usque 15 cm longis terminales, congestae, cylindricae, floribus omnibus simultaniter apertis brevipedicellatis in gregibus 8 -- 11 trifloris aggregatis, grege omni a bractea 4 -- 5mm longa, 3 mm lata, acuminata, 10 -- 12 nervata subtenta, bracteis apicem inflorescentiae versus magnitudine decresentibus. Flores pallide citrini nervis vexilli purpureo-brunneo-suffusis, 7 -- 10 mm longi bracteis anguste lanceolatis 3 mm longis. Calyx 7 -- 9 mm longus hirsutus, quam corolla brevior, lobo carinalis quam aliis longiore, 7 -- 9 mm longo, 2,5 -- 3,0 mm lato, lobis lateralibus vexillaribusque brevioribus 5,0 -- 6,5 mm longis; dens vexillaris ovato-lanceolatus, reliqui lanceolati, omines acuminati venatione prominente porcata; praecipue in dens carinalis glandulosi. Vexillum 8,5 -- 9,0 mm longum, 5,5 -- 6,5mm latum. Alae 8,5 -- 9,0 mm longae, 2 mm latae. Petala carinae quam alae breviora 7 mm longa, 2,0 -- 2,5 mm lata. Androecium 6,0 -- 6,5 mm longum, stamen decimum vaginae adaxialiter fissae per dimidium longitudinis connatum. Pistillum 6,0 -- 6,5 mm longum; ovarium 2,5 mm longum sparsim glandulosum; gynophorum 6,5 mm longum; stylus glaber, entase ante et prope partem flexuosam bene evolutus; pars curvata 1,3 -- 1,5 mm longa, parte superiore incurvata, stigmate minuto penicillato. Fructus seminaque ignoti.

Fig. 9.17 *Otholobium sabulosum*. 1, Trailing stem, $x^4/_5$; 2, Terminal leaflet, x5; 3, Apex of terminal leaflet, x20; 4, Flower, x6; 5, Standard, x6; 6, Wing petal, x6; 7, Keel petal, x6; 8, Pistil, x6; 9, Upper parts of filaments with half removed to show insertion, x24; 10, Calyx opened out, inner face, x6; 11, Triplet bract, x18 (*Esterhuysen 33240a*).

Dwarf prostrate shrub up to 5 cm high. **Stems** many, branching near the base, producing numerous ascending seasonal shoots up to 15 cm in length; appressedly puberulent, purplish-brown. **Leaves** digitately trifoliolate, spreading, scarcely petiolate. **Leaflets** unequal; terminal leaflet 7 -- 12 mm long, 5 -- 7 mm wide, obovate; laterals smaller, symmetrical; overseasonal leaves larger than seasonal leaves; base cuneate, apex acuminate, mucro straight, 1 mm long; partly conduplicate, young leaves glabrous, sparsely hairy along margins, glabrescent, glands impressed, equal in number on both surfaces; petiole < 2 mm long; petiolules < 1 mm long. **Stipules** 3,0 -- 3,5 mm long, persistent, glabrous, lanceolate. **Inflorescences** terminal on short seasonal shoots up to 15 cm long, congested, cylindrical, flowers open simultaneously; comprised of 8 -- 11 triplets of shortly pedicelled flowers, each triplet subtended by a single 4 -- 5 mm long, 3 mm wide, acuminate, 10 -- 12 veined bract; bracts become smaller towards the apex of the inflorescence. **Flowers** pale lemon-coloured, veins on standard suffused purple-brown, 7 -- 10 mm long, bracts narrowly lanceolate, 3 mm long. **Calyx** 7 -- 9 mm long, hirsute, shorter than the corolla, carinal lobe longest, 7 -- 9 mm long, 2,5 -- 3,0 mm wide, laterals and vexillar lobes shorter, 5,0 -- 6,5 mm long; carinal teeth ovate-lanceolate, others lanceolate, all acute, venation prominent, ridged; glandular, predominantly on the carinal teeth. **Standard** 8,5 -- 9,0 mm long, 5,5 -- 6,5 mm wide, claw 2 mm long, elliptic, emarginate, scarcely auriculate. **Wing petals** 8,5 -- 9,0 mm long, 2 mm wide, claw 3 mm long, auriculate; sculpturing present, upper basal and upper central, comprised of 10 -- 20 irregular and differently sized transcostal lamellae. **Keel petals** shorter than wing petals, 7 mm long, 2,0 -- 2,5 mm wide, claw 4 mm long. **Androecium** 6,0 -- 6,5 mm long, tenth stamen fused to the adaxially split sheath for half its length, fenestrate. **Pistil** 6,0 -- 6,5 mm long; ovary 2,5 mm long, sparsely glandular; gynophore 0,5 mm long; style

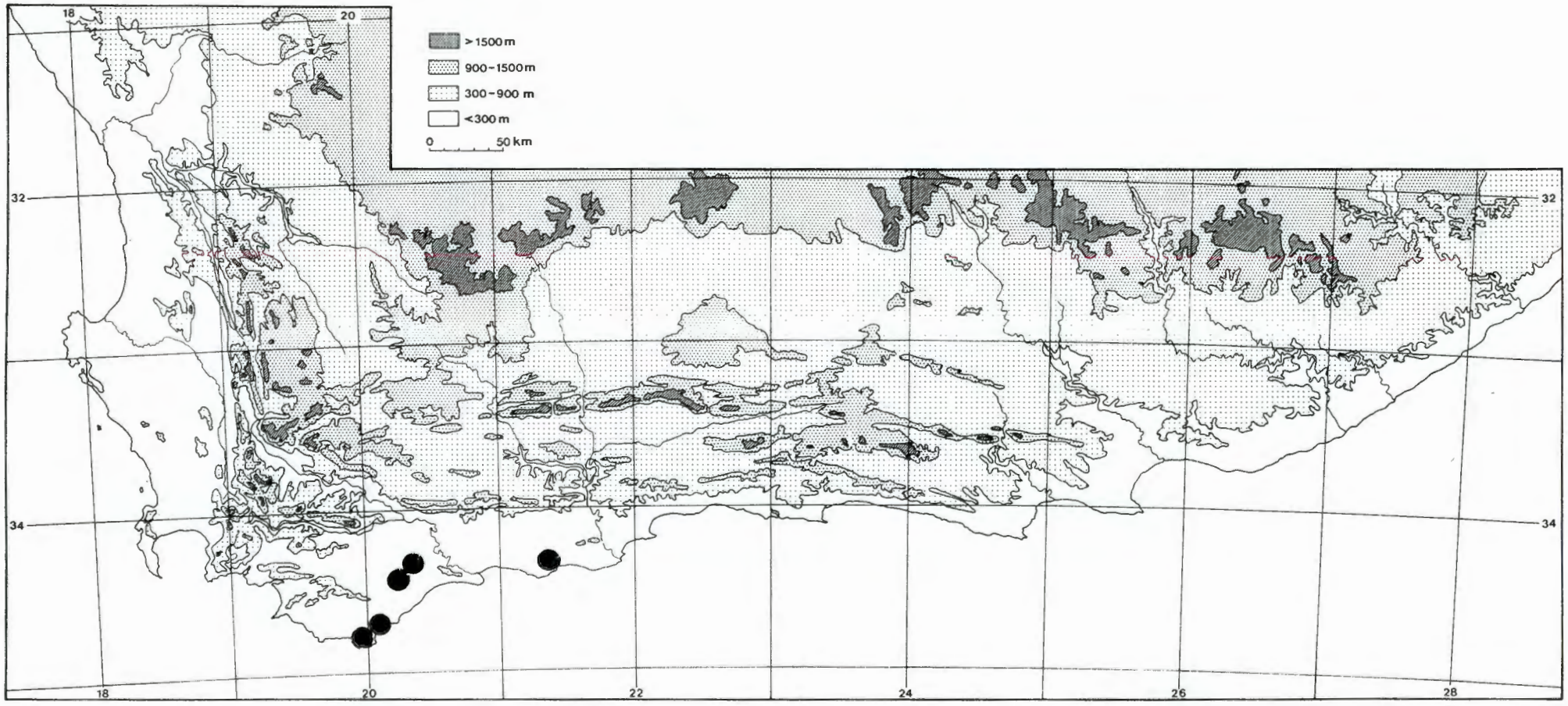


Fig. 9.18 Known distribution of *Otholobium sabulosum* C.H. Stirton in southern Africa.

glabrous, entasis well developed just before point of flexure; height of curvature 1,3 -- 1,5 mm long, upper part incurving, stigma minute, penicillate. **Fruits** and seeds unknown. Fig. 9.17.

Otholobium sabulosum is a rare species restricted to calcareous sands and calcrete outcrops of the Riversdale region (Fig. 9.18). Flowering takes place from August to October. It occurs between 60 -- 200 m. Plants generally flourish after fires.

O. sabulosum is related to *O. bracteolatum* and *O. fruticans* but differs from these species in its dwarf habit, lemon-coloured flowers, prominent straight mucro, purplish green flower bracts and carinal calyx teeth.

Plate 40.20 on page 31 in Bohnen's (1986) Flowering Plants of the Southern Cape, cited as *O. fruticans*, is this species.

Specimens examined

-3419 (Caledon) Sweetwatersand Nature Reservse (-DD), 18-2-1988, *Bean 2002*, (BOL).

-3420 (Riversdale): Hills N of De Hoop Vlei (--AB), 25-8-1973, *Esterhuysen 33240a* (BOL, K); Panorama Circle (--AD), 24-9-1978, *Bohnen 4212* (STE); De Hoop (--AD), 8-1969, *Van der Merwe 1094* (PRE); Hamerkop (--BC), 19-9-1984, *C.M. Van Wyk 1912* (NBG, PRE); Die Mond (--CA), 8-10-1950, *Martin 586* (NBG).

-3421 (Riverdale): 8 km along Hectorskraal road to Still Bay (-BD), 7-12-1986, *Vlok 1743* (NU, SAAS).

8. Otholobium arborescens C.H. Stirton, *sp. nov., O. striati affinis sed habitu valde altiore virgato, ramis laxe foliosis, seminibus in fructu non reticulato ex calyce non accrescenti protuberante inclusis, et inflor- escentibus laxis differt.*

Typus: Spektakel Pass (--DA), 5-12-1981, *Stirton 10153* (NBG, holo; K, MO, PRE, iso).

Frutex altus virgatus vel arbor parvus usque 5 m altus. Caules 1 -- 5, prope basin ramosi, ramis pallide brunneis; ramunculi laxe foliosi, hinnulei, pustulati, canescentes valde glabratim costati, ramulis novis appresse puberulis, viridi-albidis, virgatis. Folia trifoliolata, petiolata. Foliola 10 -- 14 (16) mm longa, 4 -- 6 mm lata, complicata ascendentia, arcuata, mucrone < 1 mm longa, apice emarginata recurvato-mucronata; venae graciles in pagina inferiore indistinctae; glandulae utrinque frequentes sed superne densiores, impressae; appresse pubescentia, glabrescentia; glandulis post casum persistentibus maculata; petioli 1 -- 2 mm longi; petioluli 2 mm longi. Stipulae 2,5 -- 4,0 mm longae, rectae, setosae, dense glandulosae, amplectantes vel aliquantum patentes. Inflorescentiae spicatae, in ramulis virgatis 20 -- 30 cm longis annuis terminales, pedunculo 10 -- 35 mm longo; quam folia a quibus subtentae triplo vel quadruplo maiores, laxae, floribus brevi-pedicellatis in gregibus 9 -- 13 trifloris aggregatis, grege omni a bractea cucullata late lanceolata puberula glandulosa, 2,5 mm longa, 2 mm lata caduca subtenta. Flores 7 -- 8 mm longi, ebracteati, eburnei. Dentes calycis quam tubus breviores, ovati vel ovato-lanceolati, subaequales, lobis 6 -- 7 mm longis, tubo 4 mm longo; lobo carinale quam alii breviore sed parum latiore, lobis vexillaribus usque 2 mm ultra tubum connatis; canescento-pubescentes, in dentibus solum vel ubique glandulosi; calyx in fructu accrescens. Vexillum 7 mm longum, 5,0 -- 5,5 mm latum, obovatum, apice emarginatum, auriculatum, quam alii brevius. Alae 7 -- 8 mm longae, 2,0 -- 2,5 mm latae, ungue 3 -- 4 mm longo, quam vexillum et carina longiores. Petala carinae 7 mm longa, 2 mm lata. Androecium 6,5 -- 7,0 mm longum, stamen decimum tertio inferiori in lato sinistro vagini adaxialiter fissi leviter adhaerens. Pistillum 6,0 -- 6,5 mm longum;

Fig. 9.19 *Otholobium arborescens*. 1, Flowering shoots, $x^2/_3$; 2, Pinnately trifoliolate leaflet, x1,5; 3, Side view of flower just after anthesis, x5; 4, Standard, inner face, x5; 5, Wing petal, x5; 6, Keel petal, x5; 7, Pistil, x5; 8, Calyx opened out, inner face, x4; 9, Triplet bract, x2,5 (1-2 *Stirton 10156*; 3-9, *Stirton 10153*).

ovarium 2 mm longum, pilosum glandulosumque, parte curvata 1,5 mm alta, stylo pro parte maxima prope et ante partem flexuosam incrassato, in parte superiora ultra entasem aliquantum prorsus inclinata, stigmate penicillato. Fructus membranaceus, 5,5 -- 6,0 mm longus, 3,0 -- 3,5 mm latus, ellipticus, pubescens, glandulosus, dentes calycis excedens, reticulatione non conspicua. Semina 3,5 -- 4,0 mm longa, 3 mm lata, castaneo-brunnea, hilo inter partem centralem et apicem disposito.

Tall, virgate shrub, or small tree, up to 5 m tall. **Stem** up to 5 -- 6, branched from near the base, branches pale brown; twigs laxly leafy, tan, pustulate, canescent with distinct glabrous ribbing; new shoots appressed puberulent, greenish white, virgate. **Leaves** pinnately trifoliolate, sub-sessile. **Leaflets** 10 -- 14 (16) mm long, 4 -- 6 mm wide, conduplicate, ascending, arcuate, mucro <1 mm long; apex emarginate, recurved-mucronate, base acute; slender veins not obvious on lower surface; glands common on both surfaces, but denser on upper surface, impressed; appressedly pubescent, becoming glabrous; petiole 1 -- 2 mm long, gland dotted, persistant once leaflets have dropped; petiolules 2 mm long. **Stipules** 2,5 -- 4,0 mm long, straight, linear, densely glandular, clasping, caducous. **Inflorescences** spicate; terminal on laxly leaved, 20 -- 30 cm long, seasonal, virgate shoots; peduncle 10 -- 35 mm long; 3 -- 4 times greater than the subtending leaves, lax, comprised of 9 -- 13 triplets of flowers with 3 mm long pedicels; each triplet subtended by a cucullate, broadly lanceolate, puberulent, glandular, 2,5 mm long, 2 mm wide, caducous bract. **Flowers** 7 -- 8 mm long, ebracteate, cream-coloured. **Calyx teeth** shorter than the tube, ovate to ovate-lanceolate, subequal; lobes 6 -- 7 mm long, tube 4 mm long; carinal lobe shortest but slightly wider, vexillar lobes fused for 2 mm above the tube; cano-pubescent, glandular either on the teeth or over the entire outer surface of the lobes; calyces not accrescent in fruit. **Standard** 7 mm long, 5,0 -- 5,5 mm wide, claw 2 -- 3 mm long, obovate, apex retuse, auriculate, shorter than the wing petals. **Wing petals** 7 -- 8 mm long, 2,0 -- 2,5 mm wide, claw 3 -- 4 mm long, longer than

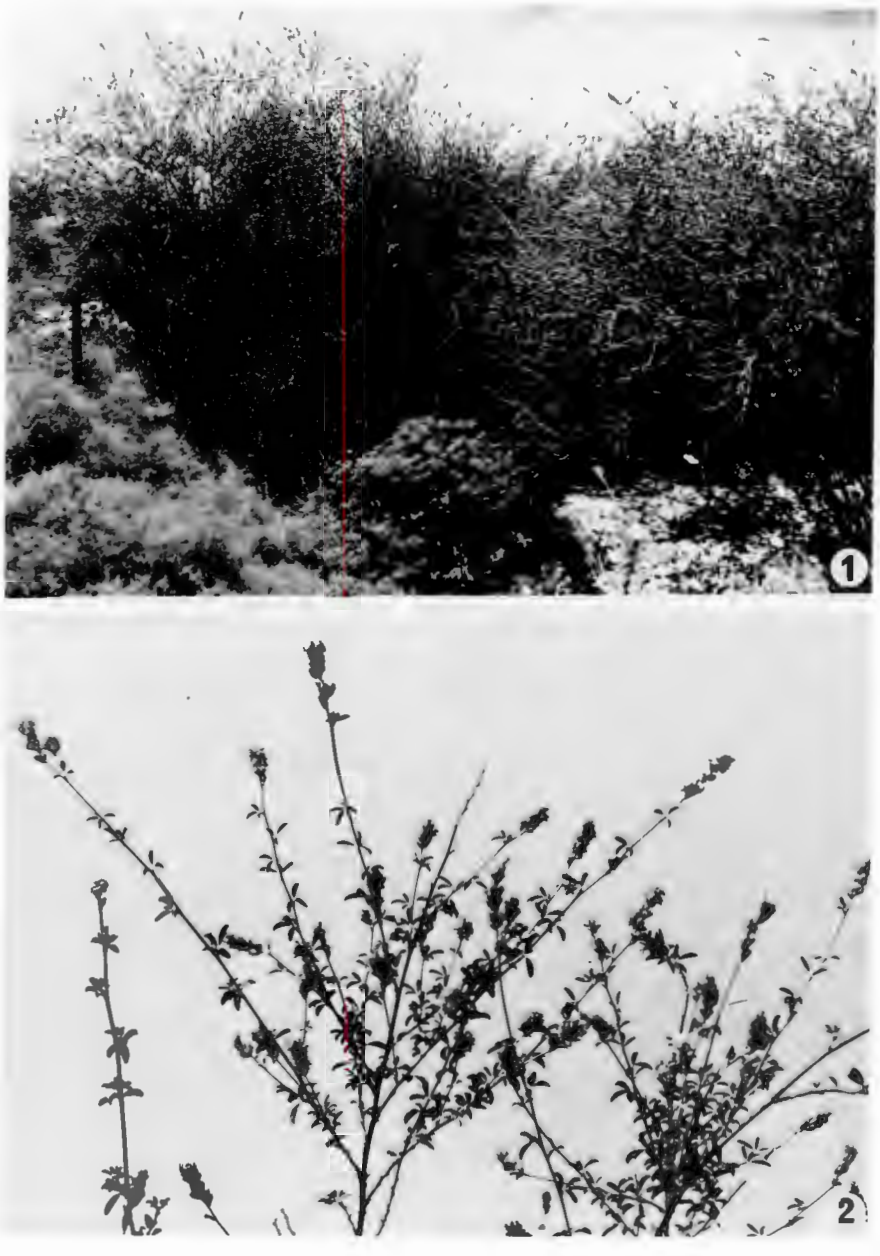


Fig. 9.20 *Otholobium arborescens*. 1, Dense shrubs with virgate upper branches; 2, Close up of seasonal shoots, each terminated by 1-2 inflorescences (*Stirton 10153*).

standard and keel petals, distinctly auriculate; sculpturing upper central, comprised of 13 -- 16 irregular rows of transcostal lamellae. **Keel petals** 7 mm long, 2 mm wide, claw 4 mm long. **Androecium** 6,5 -- 7,0 mm long, vexillar stamen lightly adherent to lower third of the left side of the adaxially slit sheath. **Pistil** 6,0 -- 6,5 mm long; ovary 2 mm long, pilose and glandular, height of curvature 1,5 mm, entasis thickens just before the point of flexure, upper part beyond the entasis somewhat forward sloping, stigma penicillate. **Fruit** membranous, 5,5 -- 6,0 mm long, 3,0 -- 3,5 mm wide, elliptic, pubescent, glandular, exerted beyond calyx teeth, reticulation not evident. **Seeds** 3,5 -- 4,0 mm long, 3 mm wide, chestnut brown, hilum between centre and apex. Figs. 9.19 & 9.20.

Otholobium arborescens appears to be endemic to Mountain Renosterveld (Acocks's veld type No. 43; Fig. 9.21). This vegetation type includes the falsely karroid parts of the mountainous areas where renosterbos (*Elytropappus rhinocerotis*) is either the natural dominant or which shows no sign of becoming an invader of some other veld type (Acocks, 1975). Flowering takes place from October to December. However, there are two records of flowering taking place in the Hester Malan Nature Reserve during July and August. It occurs between 250 -- 500 m altitude.

O. arborescens is most closely related to *O. striatum*. These two species are separated from all other Otholobiums by their distinctive calyx with its recurving teeth and wing petals exceeding the standard. The flowers of *O. striatum* and *O. arborescens* are very similar, differing only in the auriculation of the standard and glandulosity of the ovary. They are however easily distinguished in the field in habit, leaf hairiness and glandulosity, calyx shape in fruit, seed colour and fruit shape. *O. arborescens* is separated from *O. striatum* by its considerably taller and virgate habit, laxly leafy branches, scarcely visible secondary venation of the light green leaves, quite obvious presence of glands on both surfaces, less dense inflorescences, non-reticulate fruits protruding from a non-

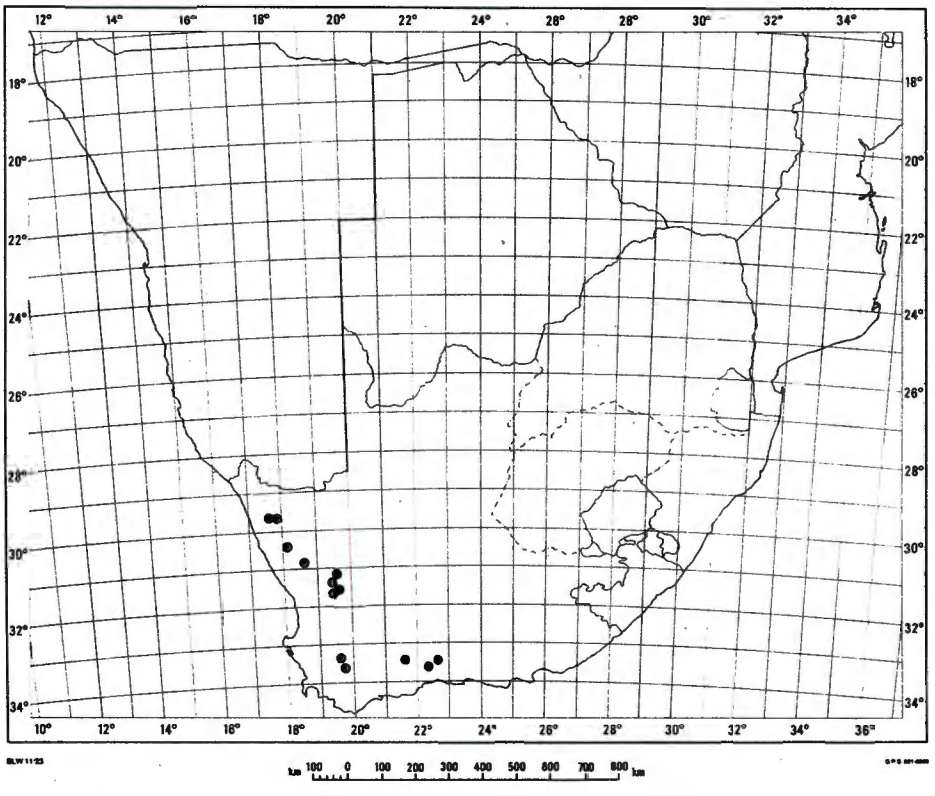


Fig. 9.21 Known distribution of *Otholobium arborescens* C.H. Stirton in southern Africa.

accrescent calyx when mature and chestnut-brown seeds. *O. striatum* is a shorter, more compact shrub with densely leafy branches; distinctly visible secondary venation on the dark green densely appressed puberulent leaves; glands absent or scarcely obvious below, dense inflorescences, reticulate fruits completely enclosed in an accrescent calyx at maturity and; seeds black. The two species are also found to occupy quite different types of habitat. *O. arborescens* looks very similar to *O. striatum* in the herbarium but inspection in the field shows these two species to be quite distinct.

Specimens examined

-2917 (Springbok): Spektakel Pass (--DA), 5-12-1981, *Stirton 10153* (K, PRE); 3-11-1982, *Rourke 1781* (K, NBG, PRE); Hester Malan Nature Reserve (--DB), 22-11-1973, *Rösch & Le Roux 182* (STE); 24-11-1973, *Rösch & Le Roux 210* (STE); 15-11-1976, *Van Der Westhuizen 9/77* (STE); 14-7-1975, *Le Roux 1200* (PRE); 23-8-1976, *Grobbelaar 1976* (PRE); 5-12-1973, *Dumoulin 7* (PRE); Sandhoogte (--DB), 5-12-1981, *Stirton 10156* (K, PRE); Farm Eureka, 8 km from Springbok to Kleinsee (--DB), 5-12-1981, *Stirton 10157* (K, PRE).

-3018 (Kamiesberg): Leliefontein (--AC), 16-12-1936, *Adamson 1451* (BOL); between Brakdam and Rietkloof (--DC), 8-12-1910, *Pillans 5667, 5668* (K).

-3119 (Calvinia): Groot Toring (--BC), 8-11-1955, *Acocks 18596* (K, PRE); Kareeboomfontein (--DA), 9-12-1980, *Hanekom 2590* (PRE); Rebunie (--DB), 27-12-1977, *Hanekom 2501* (K, PRE).

-3319 (Worcester): De Doorns, Hex River Valley (--BC), 1-1908, *Bolus 13096* (BOL, K); between Hottentots Kloof and Karoo Poort (--BC), 29-11-1908, *Pearson 4805* (PRE).

-3321 (Ladismith): Gamkaskloof (--BC), 15-12-1977, *Geldenhuys 461* (PRE, SAAS).

-3322 (Oudtshoorn): 7 km S.W. of De Rust (--CB), 22-10-1959, *Acocks 20785* (PRE).

Without precise Locality: Namaqualand Minor, *Scully 1137* (BOL, G, STE).

9. Otholobium uncinatum (Eckl. & Zeyh.) C.H. Stirton in S. Afr. J. Bot. 52: 4 (1986).

Psoralea uncinata Eckl. & Zeyh.., Enum. 231 (1836); Forbes in Bothalia 3: 120 (1930); Adamson & Salter, Fl. Cape Penins. 488 (1950). Lectotype: "Tulbagh", *Zeyher* s.n. (S, lecto; K, L, S, SAM, W, iso).

P. cephalotes E. Mey., Comm. 87 (1836) non Eckl. & Zeyh. (1836). Syntypes: "Inter Simonsberg et Tygerberg", *Drège* s.n. (K, S, W); "Klein Draakenstein", *Drège* s.n. (K, MO). The latter collection is *Otholobium bracteolatum* (Eckl. & Zeyh.) C.H. Stirton.

P. hirta L. var. *jacquiniana* sensu E. Mey. in Linnaea 7: 165 (1832) non DC. (1825).

Spreading to erect shrub. **Stem** 6 -- 10, branched repeatedly along their length; branches up to 60 cm long, decumbent. **Leaves** pinnately trifoliolate, shortly petiolate. **Leaflets** 12 -- 20 mm long, 3 -- 5 mm wide, narrowly obovate, erect to patent, apex acute, base cuneate, half-conduplicate, pellucid-dotted when fresh, glands drying pale brown; glands prominent along margin; younger leaves sparsely puberulent on both surfaces, densest along margins, becoming glabrous with age; petiole 1 mm long, petiolules 0,5 mm long. **Stipules** 4 -- 5 mm long, narrowly tapered, much longer than the petiole, recurved, sericeous, persistent. **Inflorescences** axillary, 1 -- 4 clustered at the ends of short shoots, each inflorescence <10 mm long, comprised of 1 -- 3 triplets of sessile flowers, each triplet subtended by a single 3 -- 5 mm long, 2 -- 4 mm wide, broadly ovate, acute, sparsely hairy, multinerved bract; peduncle 5 -- 6 mm long, shorter than subtending leaves. **Flowers** 7 mm long, pale mauve with purple marks above the greenish white nectar patch; sessile, each flower subtended by a 2 -- 3 mm long, 1,0 -- 1,5 mm wide,

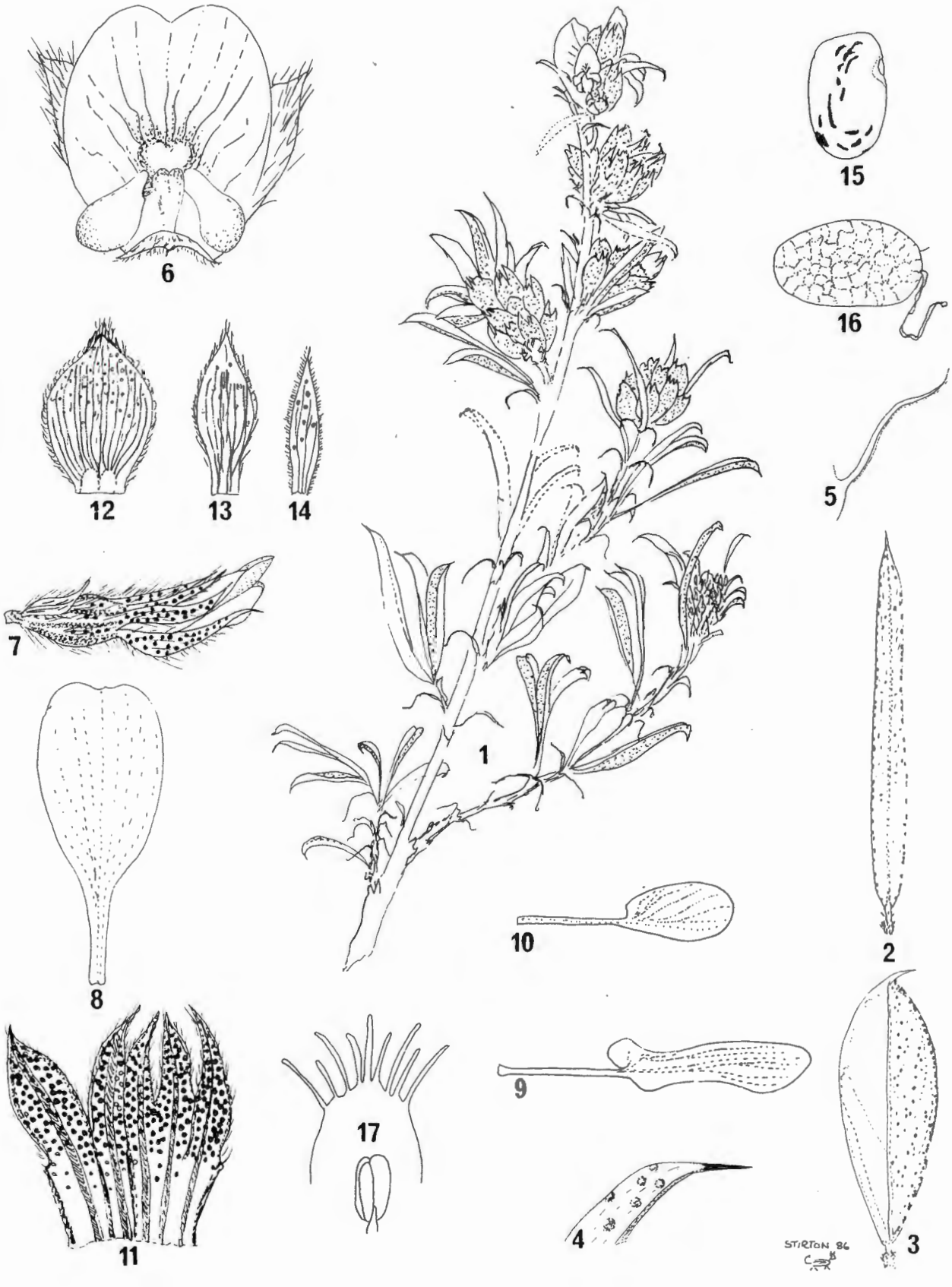


Fig. 9.22 *Otholobium uncinatum*. 1, Flowering branch, x1; 2, Terminal leaflet of new shoot growth, x2; 3, Terminal leaflet on overseasonal shoots, x2; 4, Apex of terminal leaflet, x3; 5, Stipule, x5; 6, Flower, face view, x6; 7, Flower, side view, x8; 8, Standard, x8; 9, Wing petal, x8; 10, Keel petal, x8; 11, Calyx opened out, inner face, x6; 12, Triplet bract, x10; 13, Flower bract, x10; 14, Bracteole, x10; 15, Seed, x10; 16, Fruit, x10; 17, Upper parts of filaments and representative anther, x20; (1,4-17, *Stirton 8444*; 2-3, *Rogers 21173*).

than the calyx tube; equal, purple tinged, acute, carinal lobe broader than the other lobes, 7 -- 10 mm long, 2 -- 3 mm wide; vexillar lobes fused higher up than the rest; hirsute, hairs white; teeth densely glandular. **Standard** 7,0 -- 7,5 mm long and wide, pinkish mauve in upper two thirds of inner face, obovate, reflexed by 60 degrees, sides somewhat flared backwards, scarcely auriculate; claw 1,5 -- 3,0 mm long, 1,0 -- 1,5 mm wide, claw 2 --3 mm long, prominently rounded, auriculate; longer than keel petals; sculpturing upper central, comprised of 6 -- 13 irregular transcostal lamellae, rows distinct. **Keel petals** 4 -- 5 mm long, 1,0 -- 1,5 mm wide, claw 2,5 -- 3,0 mm long; shorter than wing petals; blade distinctly rounded. **Androecium** 4,5 -- 6,0 mm long, sheath split adaxially, tenth stamen free, anthers equal, 0,3 mm long. **Pistil** 4 -- 8 mm long; ovary 1 -- 2 mm long, stipitate, 0,5 mm long, hairy on sides, otherwise glabrous; style thickened before point of flexure, height of curvature 1,5 mm, forward sloping, stigma exserted, penicillate. **Fruits** papery, markedly reticulate, 4 mm long, 2,5 mm wide, sparsely pubescent; style persistent. **Seeds** 2,5 -- 3,0 mm long, <2 mm wide, dull olive brown with purple stripes, hilum area orange. Fig. 9.22.

O. uncinatum occurs on higher elevations in scattered remnant pockets of South West Coast Renosterbosveld (Fig. 9.23), also referred to as Coastal Renosterveld by Acocks (1975). Flowering takes place in November and December.

The following insects, collected by myself, have been identified by the British Museum of Natural History, London: *Anoplocnemis annulicornis* (Germer) - Coreidae, Heteroptera; often cause die-back of the growing tips. About 20 insects were found on each plant and seemed to be feeding exclusively on this species wherever it was growing.

The small, short, compacted inflorescences, much branched diffuse habit, variably shaped leaves, and bicoloured striped seeds distinguishes this species from all others (Fig. 9.24).

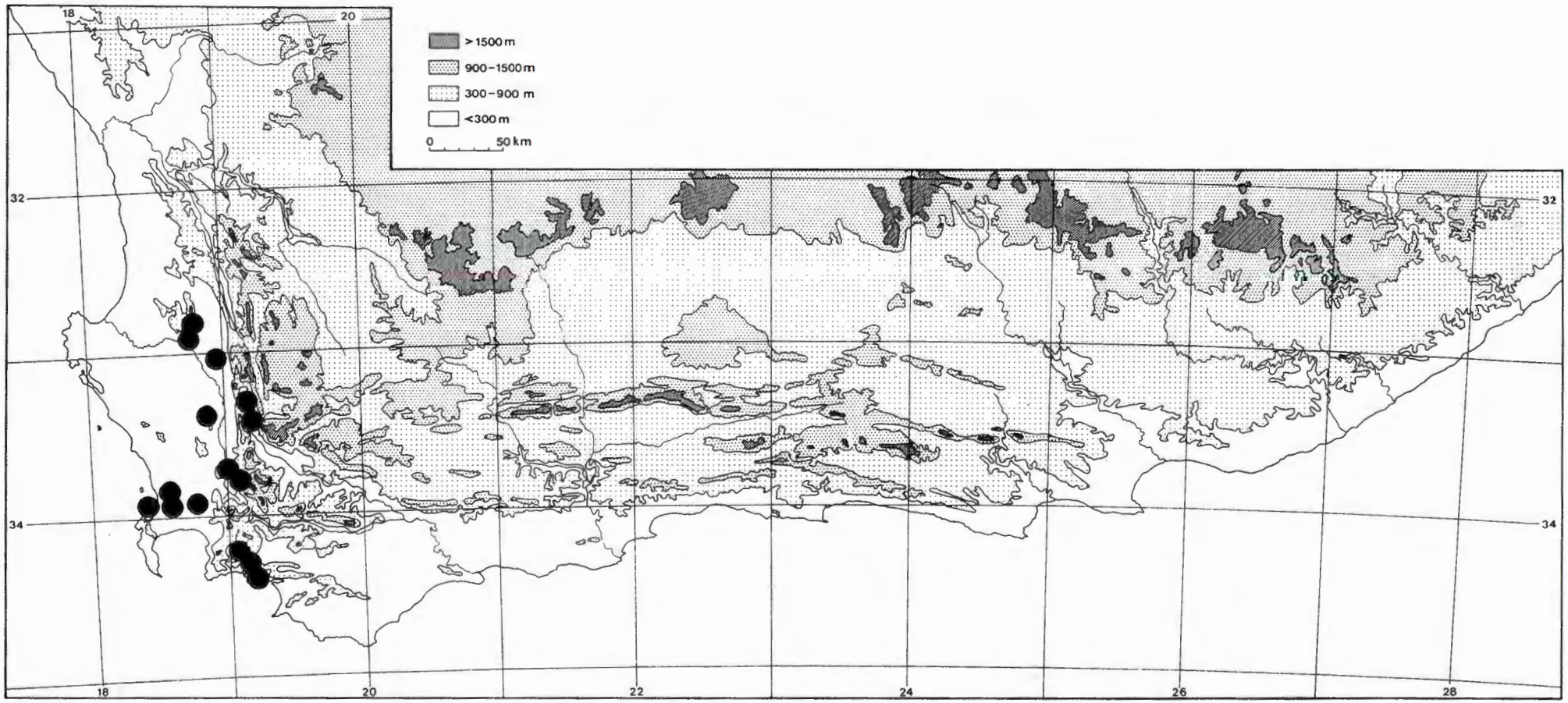


Fig. 9.23 Known distribution of *Otholobium uncinatum* (Eckl. & Zeyh.) C.H. Stirton in southern Africa.

Specimens examined

-3218 (Clanwilliam): Piquetberg (--DD), 2-1-1926, *Theiler 29* (PRE); bottom of Versfeld Pass (--DD), 5-11-1934, *Pillans 7141* (BOL).

-3318 (Cape Town): Vier-en-twintigriviersberge (--AA), *Zeyher 23* (SAM 15414); Tulbagh Waterfall (--AC), *Zeyher* s.n. (MEL 1542088); Wintershoek Mountains (--AC), *Zeyher* s.n. (SAM 15415); Artois (--AC), 2-12-1980, *Stirton 8444* (K); Tulbagh Road (--AC), 11-1919, *Rogers 17341* (BOL, PRE); Tulbagh (--AC), *Ecklon* s.n. (G, K, SAM, W); east slopes of Riebeek Mountain (--BD), 12-1930, *Pillans 6296* (BOL); Klein Drakenstein Mountains (--CC), *Drège* s.n. (K); Lions Head (--CD), 2-1921, *Guthrie* s.n. (BOL); 2-11-1938, *Penfold 102* (NBG); 10-12-1927, *Young 401* (PRE); Paarl (--DB), 1847, *Alexander* s.n. (K); near Porterville (--DB), *Edwards 249* (BOL); Belville (--DC), 12-8-1979, *Raitt* s.n. (NBG); Durbanville (--DC), 29-12-1951, *Lewis* s.n. (NBG); between Simonsberg and Tygerberg (--DC), *Drège* s.n. (G, K); Pause's Plot, Agter Paarl Road (--DD), 2-12-1968, *Marsh 1079* (PRE).

-3419 (Caledon): near Krom River (--AA), 4-1926, *Duthie* s.n. (STE); Nieuwe Kloof (--AC), 9-11-1896, *Schlechter 9038* (G, K, PRE, W); 5 km from Hawston to Kleinmond (--CC), 14--1986, *Stirton 11128* (K, MO, NBG, PRE, STE).

Without precise locality: CBS, *Drège* s.n. (G); CBS, *Harvey* s.n. (K); Tamboerskloof, 28-11-1938, *Salter 7864* (BOL); CBS, 1827, *Sichmann* s.n. (G).

10. Otholobium bolusii (Forbes) C.H.Stirton in S. Afr. J. Bot. 52: 2 (1986); Gibbs Russell et al., Bot. Surv. Mem. S. Afr. 51: 88 (1987).

Psoralea bolusii Forbes in Bothalia 3: 123 (1930). Holotype: in mountains near Piquetberg, *Bolus* s.n. (NH 16913, holo; PRE, iso).

Sprawling lax shrub up to 40 cm high. **Mature stems** glabrous, up to 2 m tall; seasonal shoots green, often blackish above, hirsute, white haired. **Leaves** pinnately trifoliolate, stipulate. **Leaflets** subequal, (10) 15 -- 20 (28) mm long, (2) 3 -- 4 (8) mm wide, shorter and much broader in lower axils, laterals smaller and somewhat assymmetrical, flat with later produced leaves arching and complicate; narrowly oblong to lanceolate, oblanceolate in lower axils, arching, sparsely albo-pilose above and below, especially along margins and on the prominent lower midrib, becoming almost glabrous, glands pellucid, drying black, prominent on both surfaces; petiole 2,5 -- 3,0 mm long, persistent after leaves abscise, rachis 1,5 -- 2,0 mm long; petiolules 0,6 -- 0,7 mm long. **Stipules** yellowish green, striate, 4 -- 6 mm long, 2 mm wide, subulate, acute. **Inflorescences** axillary at the apex of densely leafy shoots, pseudospicate, comprised of a single triplet of pedicellate flowers, each triplet subtended by a caducous, lanceolate, 2 --3 mm long, ciliate, single-veined bract; peduncle <1 mm long. **Flowers** 8 -- 10 mm long, pedicel 1 -- 3 mm long; pink. **Calyx** shorter than the corolla, carinal lobe longest, 7 -- 8 (11) mm long, 1,5 -- 2,0 mm wide, lanceolate; laterals equal to or shorter than the carinal lobe, 7 -- 8 mm long; vexillar lobes shortest; 5 -- 6 mm long, narrowly lanceolate to linear, acute, not fused above the tube; yellowish but veins green, shaggy; glandular. **Standard** 10 mm long, 6 -- 7 (8) mm wide, claw 3 mm long, broadly emarginate, very broadly ovate to oblong, scarcely reflexed, pale pink but maroon at the point where the keel hits it on tripping, flecked with white. **Wing petals** 9 -- 10 mm long, 2,5 -- 3,0 mm wide, claw 2,5 --

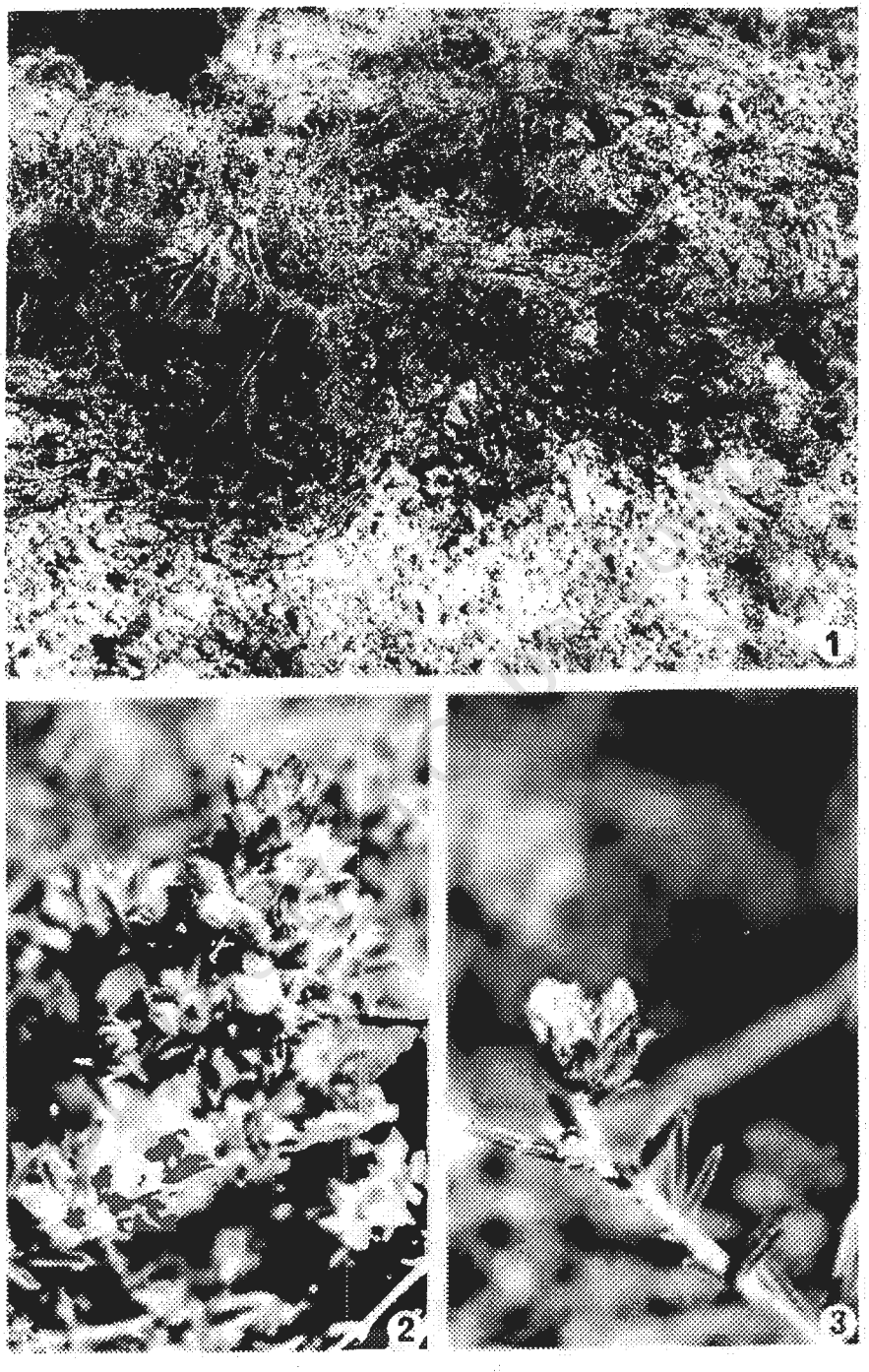


Fig. 9.24 *Otholobium uncinatum*. 1, Sprawling habit, note the trailing branches; 2; Compacted infructescences; 3, Inflorescence with all flowers opened simultaneously (*Stirton 11128*).

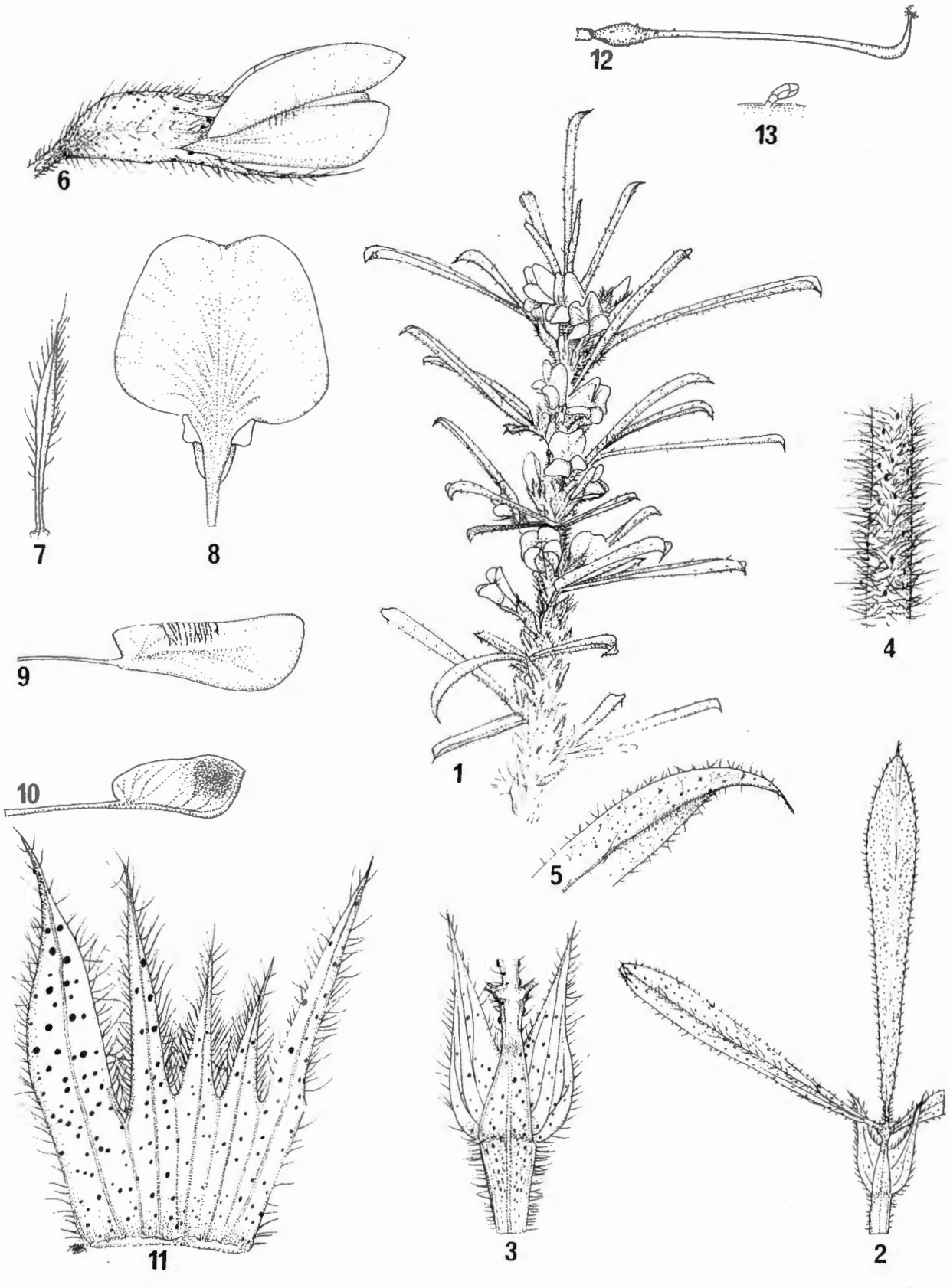


Fig. 9.25 *Otholobium bolusii*. 1, Flowering shoot, x1; 2, Pinnately trifoliolate leaflet, x2,5; 3, Paired stipules fused to petiole and exceeding it, x5,5; 4, Stem vestiture, note glands, x4; 5, Apex of terminal leaflet, with setiferous recurved mucro, x5; 6, Side view of flower at anthesis, x5; 7, Lanceolate, ciliate, single-nerved triplet bract, x7; 8, Standard, inner face, x5; 9, Wing Petal, x5; 10, Keel petal, x5; 11, Calyx opened out, inner face, x8; 12, Pistil, x9; 13, Stalked gland of ovary, x50 (*Stirton 6134b*).

3,0 mm long, longer than keel petals, auriculate, white but flushing pink towards the tip, ridged; sculpturing present, upper central, comprised of 20 -- 25 irregular lamellae, rows indistinct. **Keel petals** 3 mm long, 1,5 -- 2,0 mm wide, claw 3 mm long. **Androecium** 5,5 -- 6,0 mm long, vexillar stamen lightly adherent in lower half to split adaxial sheath, fenestrate. **Pistil** 5,5 -- 6,0 mm long; ovary 1,0 -- 1,3 mm, glabrous, stipitate, stalked glands present; entasis developed maximally before the point of flexure, height of curvature 1,3 -- 1,5 mm long, stigma penicillate. **Fruits** and seeds unknown. Fig. 9.25.

Otholobium bolusii occurs as occasional plants across a broad area of the SW Cape bounded by Klipheuwel in the south and Redelinghuys in the north (Fig. 9.26). It occurs predominantly in areas of Mesic Mountain Fynbos and West Coast Renosterveld, favouring sandstones and shale substrates between the altitudes 150 -- 1000 m. Flowering takes place from August to December with a peak in September and October.

O. bolusii is most closely related to *O. virgatum* but differs from that species in its much longer linear-oblong leaflets, narrowly lanceolate to linear calyx teeth, pink flowers, and narrowly oblanceolate flower bracts. The species exhibits considerable variation in leaf form; *Acocks 19695* (K, PRE) in particular has long, narow, conduplicate scarcely glandular leaflets and bluish flowers and may be an undescribed taxon. More collecting is needed from this grid area.

Specimens examined

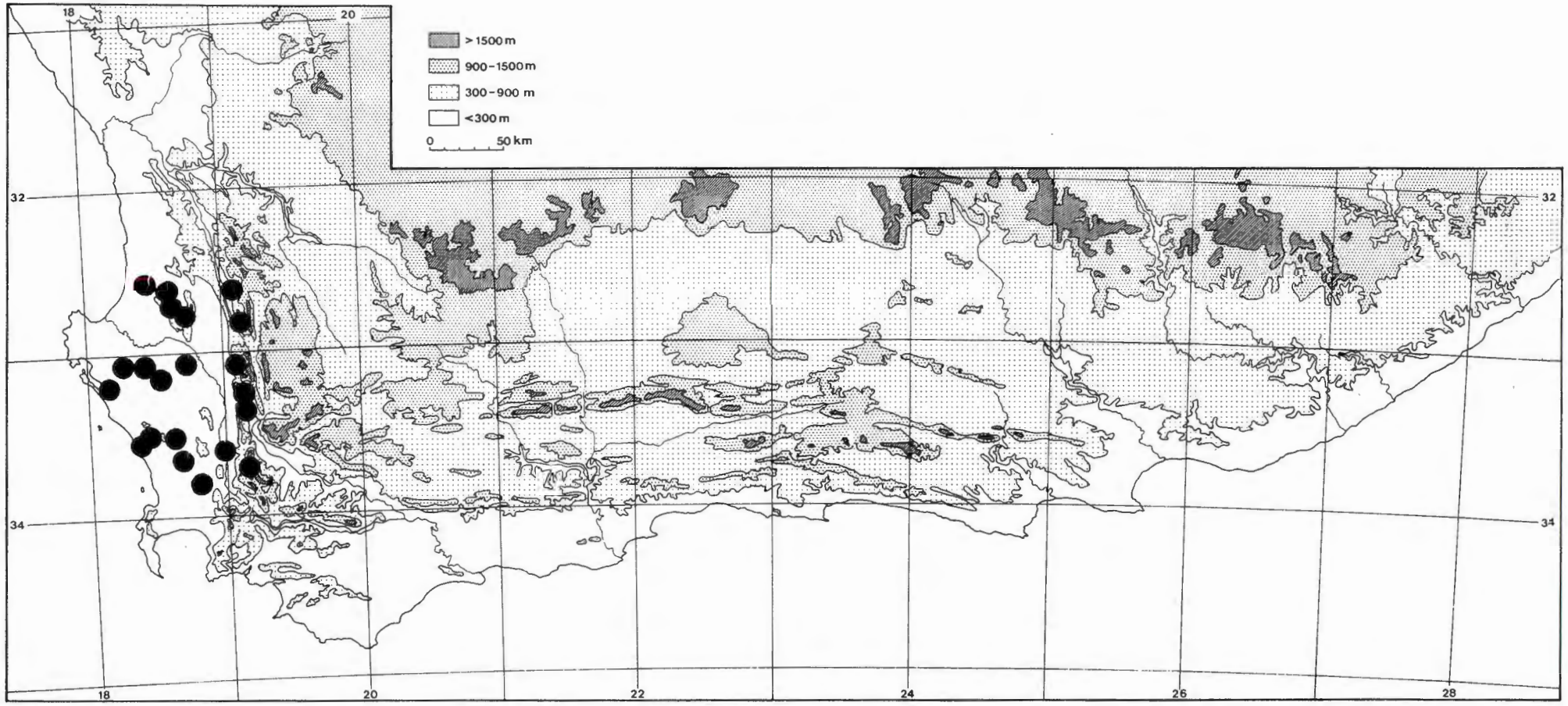


Fig. 9.26 Known distribution of *Otholobium bolusii* (Forbes) C.H. Stirton in southern Africa.

-3218 (Clanwilliam): north of Moorreesburg (--DA), 13-10-1959, *Acocks 20658* (K, PRE); Waboom farm, Zebrakop (--DA), 14--11-1963, *Taylor 5356* (PRE); 17 km SW of Redelinghuys (--DA), 25-8-1958, *Acocks 19695* (K, PRE); Kapteinskloof (--DC), 5-9-1976, *Stirton 6134b* (K, PRE); Piquetberg Mountains (--DD), 9-1895, *Bolus* s.n. (NH, PRE).

-3219 (Wuppertal); Middelberg, Elandskloof (--CA), 16-9-1976, *Hugo 564* (K, PRE, STE); 1-10-1972, *Thompson 1543* (K, PRE, STE).

-3318 (Cape Town): Farm Osfontein, Skurwerug (--AA), *Boucher 3248* (K, PRE, STE); Hopefield (--AB), 1-10-1943, *Leighton 455* (BOL); near Moorreesburg (--BA), 10-1902, *Bolus 9957* (BOL, PRE); Groenekloof (--CB), 10-1898, *Bolus 4272* (BOL); Mamre (--CB), *Ecklon & Zeyher* s.n. (MEL); Buck Bay farm (--CB), 30--11-1978, *Boucher 4167* (PRE, STE); 33 km from Cape Town to Paarl (--DA), 11-9-1938, *Gillett 4151* (K, PRE); Klipheuwel (--DA), 16-9-1982, *Van Zyl 3212* (PRE, STE); 11-1919, *L. Bolus* s.n. (BOL, STE); Olyvenbosch farm, Wellington (--DB), 2-11-1931, *Salter 1770* (K); Dwars-in-die-weg farm, Devon Valley road (--DD), 25-10-1978, *Boucher 4017* (K, PRE, STE).

-3319 (Worcester): Twenty-four Rivers (--AA), 7-1941, *Leipoldt* s.n. (PRE 55319); Artois, Artoislooprivier (--AC), 2-12-1980, *Stirton* 8447 (K); Tulbaghkloof (--AC), 9-1951, *Lewis* s.n. (BOL); Du Toits Kloof (--CA), 11-1937, *Pillans 8438* (BOL).

Without precise locality: Boschberg, Piquetberg mountains, 22-9-1940, *Bond 538* (NBG); Cape, *Burmann* s.n.

11. Otholobium macradenium (Harv.) C. H. Stirton in S. Afr. J. Bot. 52: 3 (1986).

Psoralea macradenia Harv., Fl. Cap. 2: 148 (1862); Forbes in Bothalia 3: 132 (1930). Lectotype: Wanhoop, Swartberg Mountains, *Alexander Prior* s.n. (K, lecto; BOL, TCD, iso). Syntype: Mountains of Graaff Reinet, *Barber* s.n. (K, TCD).

I have been unable to trace the type of *Psoralea velutina* E. Mey. It may be synonymous with *O. macradenium*. However, as the prologue could apply to a number of *Otholobium* species I am maintaining *O. macradenium* until the type of *P. velutina* is found.

Erect shrub up to 2 m tall, resprouter. **Stems** verrucose, much branched, densely silvery-canescent when young; surface papillose, becoming yellow-brown and irregularly split with age. **Leaves** digitately trifoliate, inserted spirally, spreading. **Stipules** minute, up to 2 mm long, persistent, appressed, lanceolate. **Leaflets** 9 -- 15 mm long, 4,5 -- 9,0 mm wide, laterals somewhat smaller, those on the seasonal shoots smaller than those remaining on the overseasonal shoots; obovate, emarginate, sharply recurved mucronate, base cuneate; young leaflets silvery-canescent becoming glabrate; sparsely covered below with 20 -- 50 very prominent raised wart-like glands, glands not so evident on the upper surface, strongly pungent; petiole minute, up to 0,5 mm long; petiolules 1 mm long, sparsely glandular. **Inflorescences** axillary, up to 11 per shoot, crowded in the axils of the upper leaves, later becoming spread out with full expansion of the seasonal shoots; comprised of one triplet of sessile, or rarely subpedunculate flowers, the whole subtended by an oblong trifid 2 mm long, 1 mm wide bract, the individual flowers each with a caducous linear bract. **Flowers** purple, 10 mm long, dull white, standard tipped with reddish purple. **Calyx lobes** 4,5 -- 5,0 mm long; teeth equal, < 2 mm long but shorter than the 3 mm deep tube; silky-canescent, ribbed, scarcely glandular. **Standard**

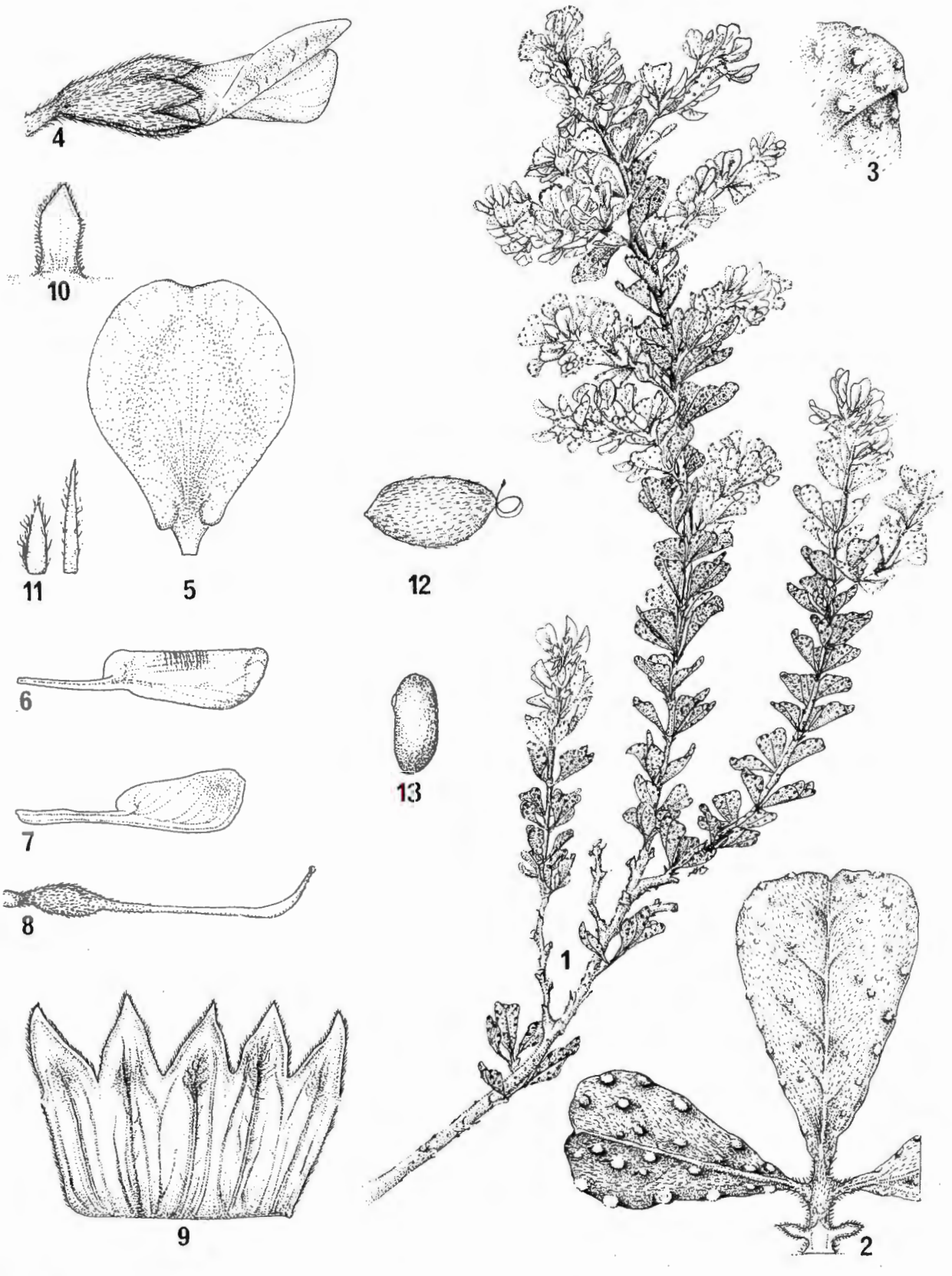


Fig. 9.27 *Otholobium macradenium*. 1, Flowering branches, x$^{3}/_{4}$; 2, Digitately trifoliolate leaflet, x5,5; 3, Apex of terminal leaflet, x5; 4, Side view of flower x5; 5, Standard, inner face, x5; 6, Wing petal, x5; 7, Keel petal x5; 8, Pistil, x7; 9, Calyx opened out, inner face, x10, 10, Stipule, x10; 11, Triplet bract, x12; 12, Fruit, x5; 13, Seed, x5 (1, *Vlok 1261*; 2-12, *Alexander Prior* s.n., K).

8,5 -- 9,0 mm long, 7,0 -- 7,5 mm wide, scarcely auriculate with 2 mm long claw; emarginate, elliptic, greenish white, with upper parts and veins purple, nectar patch large and reddish purple above claw. **Wing petals** 8 -- 9 mm long, 2 -- 3 mm wide with 2 -- 3 mm long claw; inner upper edge of wing purple; sculpturing present, upper central, comprised of 14 -- 17 vertical, thin, irregular, parallel lamellae. **Keel blades** 17 mm long, 2,5 mm wide with 4 mm long claw, purple-tipped on the inner face. **Androecium** 7 mm long, vexillar stamen fused to the base of the left hand side of the adaxially split tube. **Pistil** 7,5 mm long; ovary 2 mm long with 1 mm stalk, pubescent; height of curvature 1,5 -- 1,7 mm; style thickened and hairy before point of flexure; stigma minute, erect. **Fruit** 4 mm long, 2,5 mm wide, elliptic, finely pubescent; style curved, persistent. **Seeds** 3 mm long, 2 mm wide, dark brown. Fig. 9.27.

Otholobium macradenium is a rarely collected species described by Harvey 120 years ago, yet scarcely recognized in herbaria - which is rather surprising, given the distinctive facies of this species. Flowering takes place between November and January. A plant of drier mountain fynbos favouring northern slopes (Fig. 9.28), it occurs between 1100 - 1500 m.

This species is instantly recognized by its greenish white flowers with large reddish purple nectar patch, and silvery-canescent, cuneate-obovate leaflets, with 20 -- 30 prominent, large wart-like glands below. It is separated from *Otholobium argenteum* (Thunb.) C. H. Stirton by its dense, erect habit, habitat preference, geographical range, and type of glands. The latter species is a large spreading shrub of coastal sands and limestone outcrops and occurs in the western Cape coastal belt.

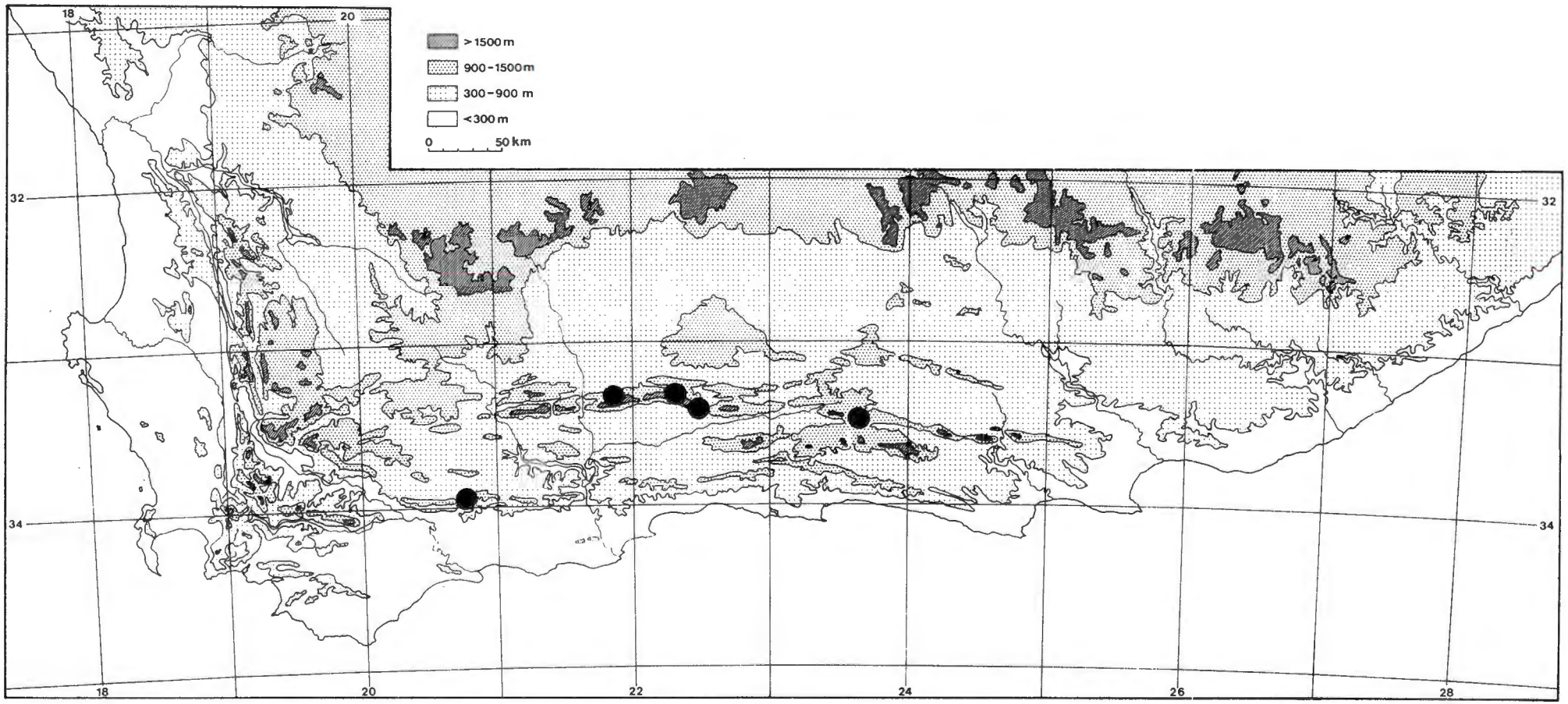


Fig. 9.28 Known distribution of *Otholobium macradenium* (Harv.) C.H. Stirton in southern Africa.

The Forester in charge of the Swartberg Forest Reserve (fide J. Vlok, pers. comm. 1986) reports that labourers hired to clear alien vegetation collect *O. macradenium* for medicinal purposes. This species has one of the most distinctive smells in the genus and is particularly pungent if the leaves are crushed. According to a note on *Stokoe 8780* it is said to have "medicinal properties". No details were given. The plants have a very distinctive odour in the field, rather like cats' urine.

Specimens examined

-3320 (Montagu): Tradouw Pass (--DD), 10-1923, *Levyns 639* (BOL).

-3321 (Ladismith): 16 km from Swartberg Pass to Gamkaskloof (--BD), *Stirton, Vlok & Zantovska 11569* (K, NBG).

-3322 (Oudtshoorn): Swartberg Pass (--AC), 12-1942, *Stokoe 8780* (BOL, SAM 56011); N slopes of Blesberge (-BC), 15-12-1986 (NU, SAAS); Swartberg Mountains near De Aap (--AD), 5-11-1985, *Vlok 1261* (K, NBG, PRE, SAAS); lower slopes of ridge leading to Spitzkop, Meirings Poort (-BC), 11-1935, *Thorne* s.n. (SAM 51844).

-3323 (Willowmore): Wanhoop, Swartberg Mountains (-BC), *Alexander Prior* s.n. (K, BOL, TCD).

Without precise locality: Graaff-Reinet area, *F.B. Barber* s.n. (K, TCD)

12. Otholobium bowieanum (Harv.) C.H. Stirton in S. Afr. J. Bot. 52: 2 (1986); Gibbs Russell *et al.*, Bot. Mem. Surv. S. Afr. 51: 88 (1981).

Psoralea bowieana Harv., Fl. Cap. 2: 154 (1862); Forbes in Bothalia 3: 127 (1930). Holotype: "Cape", *Bowie* s.n. (K, holo; BM, MO, iso). The Kew sheet merely has "Cape" as locality whereas the BM sheet, which I believe is an isotype, has the following pencilled entry: "on the Buffeljagt River at Goestervalley". Unfortunately not enough is known about Bowie's collecting localities or the quantity and distribution of his specimens to enable one to decide which is the top set. It seems probable that it is the BM material as their sheets are the better annotated.

Sprawling, erect to ascending suffrutex up to 50 cm high, coppicing after fire. **Stems** up to 60 cm long, numerous, terete, slender, puberulous, sparsely pustulate; branches filiform, flexuous. **Leaves** digitately trifoliolate, spreading. **Leaflets** unequal; terminal leaflet 14 -- 21 mm long, 8 -- 10 mm wide, obovate; laterals smaller, assymetric; overseasonal leaves larger than seasonal leaves; base cuneate; young leaves ciliate and sparsely hispid becoming glabrous with age, edges minutely serrated, nitid, dark green, mucro very sharp, glands minute, pellucid, more dense on upper surface; rachis minute, petiolules 1 mm long, sparsely glandular; petioles up to 1,5 mm long. **Stipules** 2 -- 3 mm long, subulate-linear, spreading, rapidly senescent. **Inflorescences** axillary, laxly pseudocapitate, comprised of 2 -- 5 triplets of pedicellate flowers, each triplet subtended by a single 3 -- 4 mm long, 1,0 -- 1,5 mm wide, 3 -- 5 parallel-veined, linear to oblong bract, bracts becoming smaller towards the apex of the inflorescence; each flower subtended by 1 -- 2 variously sized bracteoles, regularly on the pedicels, but caducous. **Flowers** white, 8 -- 9 mm long; bract linear, < 2 mm long. **Calyx** longer than the keel blades; carinal lobe longest, 6 -- 7 mm long, 1,5 mm wide, narrowly lanceolate; other lobes 6 mm long, vexillar lobes fused for up to one third their length above the tube; tube 2 -- 3 mm

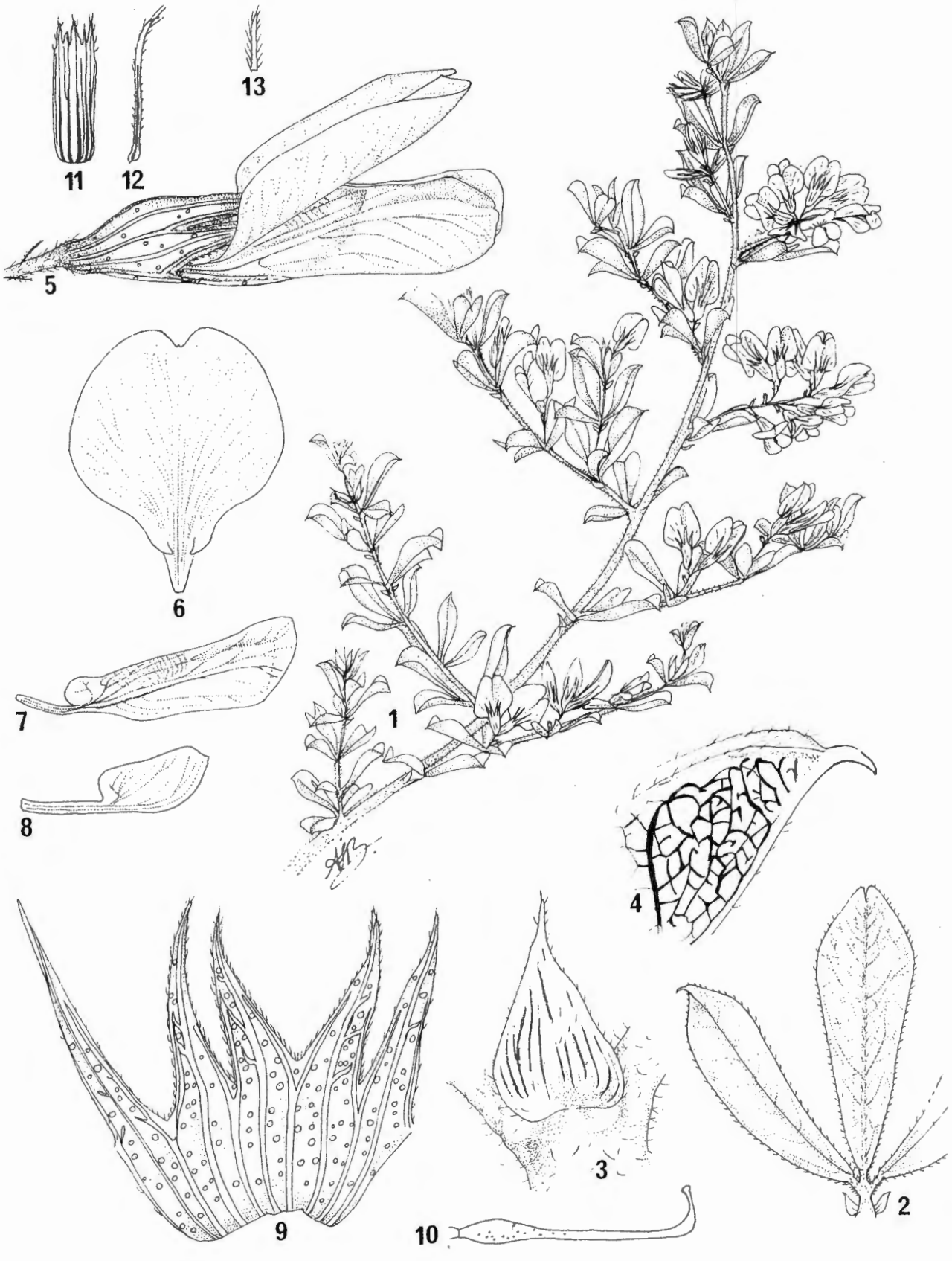


Fig. 9.29 *Otholobium bowieanum*. 1, Flowering branch, x1; 2, Digitately trifoliolate leaflet, terminal showing lower surface, laterals showing upper surfaces, x3; 3, Stipule, side view, x12; 4, Apex of terminal leaflet, x8; 5, Side view of flower at anthesis, x7; 6, Standard, inner face, x5; 7, Wing petal, x5; 8, Keel petal, x5; 9, Calyx opened out, inner face, x9; 10, Pistil, note stipitate ovary, x6,5; 11, Triplet bract, x10; 12, Flower bract, x10; 13, Bracteole, usually on pedicel, x10 (*Stirton 11549*).

long, subglabrous. **Standard** 10 mm long, 7 mm wide, elliptic; white with purple nectar patch; claw 2 mm long, auriculate; appendages absent, apex emarginate, sides tightly reflexed at anthesis. **Wing petals** 9 mm long, 2,5 -- 3,0 mm wide with 2,5 -- 3,0 mm long claw, indented along upper margin, longer than keel petals; sculpturing present, upper basal and upper central comprised of up to 30 slightly inclined transcostal lamellae, rows *indistinct.* **Keel petals** 17 mm long, 2 -- 3 mm wide, claw 4 mm long, apex rounded with mucro. **Androecium** 7 mm long, pseudomonadelphous, fenestrate. **Pistil** 6 -- 7 mm long; ovary 2,0 -- 2,5 mm long, stipitate, sparsely glandular; height of curvature 2,0 -- 2,5 mm, thickened at point of flexure; stigma small, penicillate. **Fruits** and seeds unknown. Fig. 29.

This species, endemic to the Langeberg Mountains (Fig. 9.30), is poorly represented in South African Herbaria. According to collectors it is surprisingly abundant where it occurs. Its relative scarcity is probably due to its sparse flowering and short flowering cycle.

Otholobium bowieanum inhabits the early successional stages of mountain fynbos growing on Table Mountain Sandstone. It coppices readily after fires and is well-adjusted to fire cycles. Flowering takes place from October to December. It occurs between 500 -- 650 m altitude.

It is readily separated from all other species of **Otholobium** by a combination of its pseudocapitate axillary inflorescences, bracteolate pedicellate flowers and densely sprawling habit.

Specimens examined

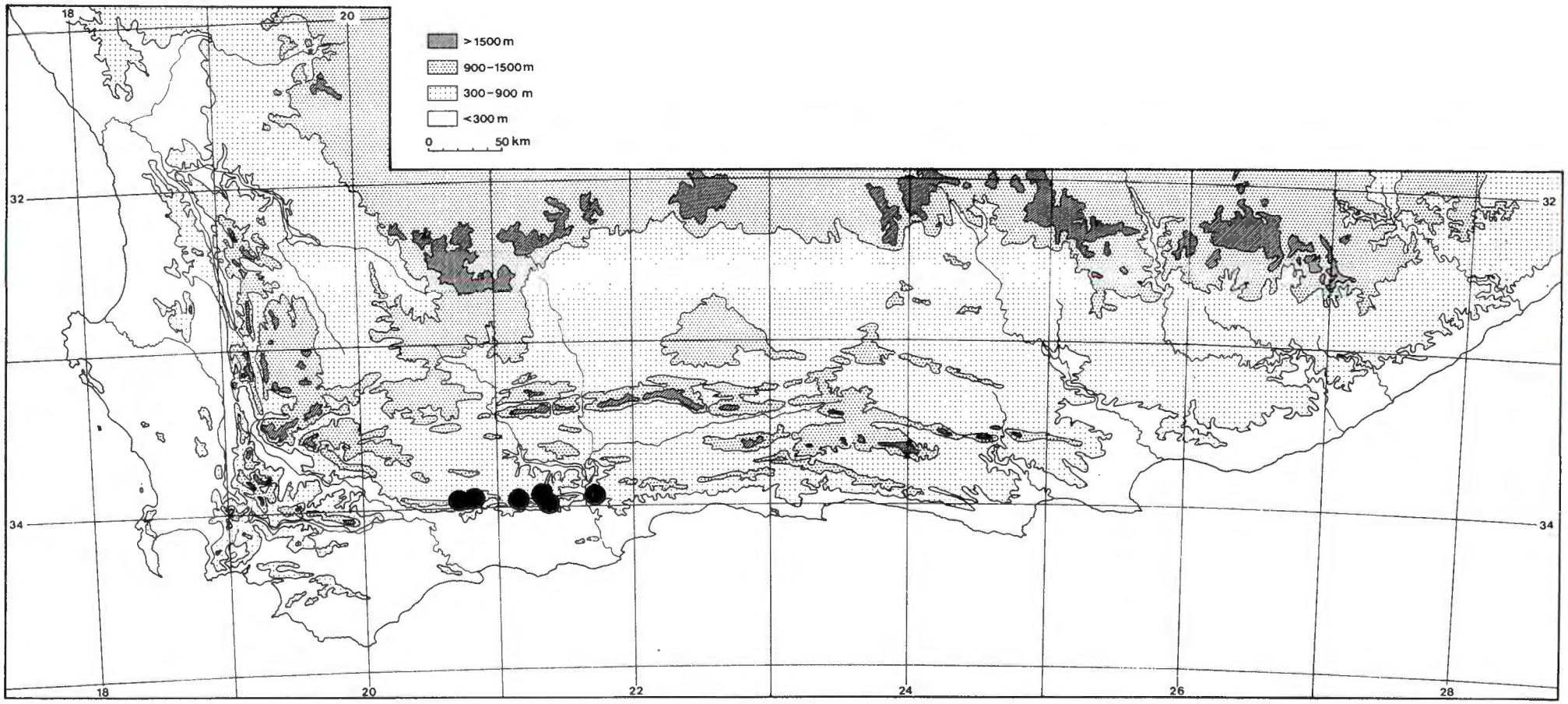


Fig. 9.30 Known distribution of *Otholobium bowieanum* (Harv.) C.H. Stirton in southern Africa.

-3320 (Montagu): Tradouw Pass (--DC), 10-1923, *J. & M. Levyns 639* (STE).

-3321 (Ladismith): Muiskraal (--CC), 28-9-1976, *Hugo 595* (K, PRE, STE); north end of Garcias Pass (--CC), 21-10-1976, *Thompson 3283* (K, MO, PRE, STE); 20 km from Riversdale to Ladismith (--CC), 10-11-1986, *Stirton & Zantovska 11544* (K, NBG); Welgemoed/Onverwacht (--CC), 12-1985, *Oliver 8804* (K, STE); 4 km from Garcias Pass to Langkloof (--CD), 10-11-1986, *Stirton & Zantovska 11549* (K, NBG); Farm Rietvallei aan de Klipheuwel, S.E. slope of junction of Kamma and Spitzkop Rivers (--DD), 7-8-1983, *Mathews 1109* (NBG).

Without precise locality: Cape, *Bowie* s.n. (K); Langeberg Mountains, *Schlechter 3355* (PRE).

13. Otholobium saxosum C.H. Stirton, *sp. nov.*

Typus: near Toll House, Garcias Pass, 10-1904, *Bolus 11264* (PRE, holo; K, NH, PRE, iso).

Suffrutex parvus usque 20 cm altus. Caules graciles, pilosi. Folia digitatim trifoliolata, petiolata. Foliola inaequales; terminale (8) 12 -- 15 mm longum, 4 -- 5 mm latum, obovatum; lateralia minora assymetrica margine superiore recti inferiore convexa, ratione 1 : 2, nervi secondarii debiles, apex acutus vel obtusus, mucrone recta; juventute sparsim pilosa glabrescens, glandulis impressis superne manifestioribus; petioli <2 mm, petioluli 1,0 mm. Stipulae 2 -- 3 mm longae, subulatae, apice attenuatae, striatae, glabrae, amplectantes. Inflorescentiae in axilibus superioribus ramulorum annuorum brevium < 30 cm floribus brevipedicellatis in grege solitaria triflora a bractea oblanceolata multinervi 3,0 -- 3,5 mm longa subtenta aggregatis, pedunculo < 2mm longo a bracteis 1 - 2 numero lanceolatis subtento. Flores 9 -- 10 mm longi, corolla calycem excedente, pedicellis 2 mm longis colore ignoto. Lobi calyces inaequales nervis prominentes lobo carinalis longiore, 8 mm longo, 1,8 -- 2,0 mm lato, quam lobis lateralibus vexilloribusque aequalibus latiore, his ultra tubum 2,0 -- 2,5 mm longum per 1 mm connatis; dentes lanceolati vel late lanceolati, acuminate, hirsuti, marginibus ciliatis; glandulae dispersae, parvae, praecipue in dentibus dispositae. Vexillum 9 mm longum, 6 mm latum, ellipticum. Alae 9 mm longae, 2,0 -- 2,5 mm latae. Petala carinae quam alae breviora, 6 mm longa, 2 mm lata. Androecium 5,0 -- 5,5 mm longum, stamine decimo libero, vagina adaxialiter fissa. Pistillum 5 mm longum; ovarium 1,0 -- 1,3 mm longum, glandulis multicellulis sparsim obtectum; gymnophorum 0,4 mm longum; stylus glaber, entase ad partem flexuosam bene evoluto, parte curvata 1,5 mm alta, stigmate capitato. Fructus seminaque ignoti.

Fig. 9.31 *Otholobium saxosum*. 1, Flowering branches, x1; 2, Digitately trifoliolate leaflet, x3; 3, Stipule, x12; 4, Apex of terminal leaflet, x6; 5, Flower, x5; 6, Standard, x5,5; 7, Wing petal, x5,5; 8, Keel petal, x5,5; 9, Pistil, x8; 10, Calyx opened out, inner face, x8; 11, Triplet bract, x7; 12, Flower bract, x7 (*Bolus 11264*).

Small semi-erect to ascending shrublet up to 20 cm tall. **Branchlets** slender, pilose, pustulate. **Leaves** digitately trifoliolate, petiolate. **Leaflets** unequal; terminal leaflet (8) 12 -- 15 mm long, 4 -- 7 mm wide, obovate; laterals smaller, assymetrical, upper margin straight, lower convex, ratio 1 : 2, secondary veins weak, apex acute to obtuse, mucro straight, sparsely pilose in younger leaves becoming glabrescent, glands impressed, more apparent on the upper surface; petioles <2 mm, petiolules 1 mm. **Stipules** 2 -- 3 mm long, subulate, apex attenuate, striate, glabrous, clasping. **Inflorescences** axillary in the upper axils of short <30 cm long seasonal shoots, congested, each comprised of a triplet of shortly pedicellate flowers and subtended by an oblanceolate to flabellate, multiveined, 3,0 -- 3,5 mm long bract, peduncle <2 mm long, subtended by 1 or 2 narrowly lanceolate bracts. **Flowers** 9 -- 10 mm long, colour unknown, pedicels 2 mm long. **Calyx** shorter than the corolla; lobes unequal, veins prominent, carinal lobe longest, 8 mm long, 1,8 -- 2,0 mm wide, broader than the equal lateral and vexillar lobes, the latter fused for 1 mm above the 2,0 -- 2,5 mm long tube; teeth lanceolate, or broadly lanceolate, acuminate, hirsute, margins ciliate; vexillar teeth not fused above the tube; glands scattered, small, mostly on the teeth. **Standard** 9 mm long, 6 mm wide, elliptic, auriculate, claw 2 mm long. **Wing petals** 9 mm long, 2,0 -- 2,5 mm wide, claw 2 mm long, auriculate; sculpturing present, upper basal, comprised of 10 -- 12 transcostal, parallel lamellae. **Keel petals** shorter than and fused to wing petals in the auricular region, 6 mm long, 2 mm wide, claw 2 mm long. **Androecium** 5,0 -- 5,5 mm long, vexillar stamen free, sheath split adaxially. **Pistil** 5 mm long; ovary 1,0 -- 1,3 mm long, sparsely covered in multicelled glands; gynophore 0,4 mm long; style glabrous, entasis well-developed at point of flexure, height of curvature 1,5 mm long, stigma capitate. **Fruits** and seeds unknown. Fig. 9.31.

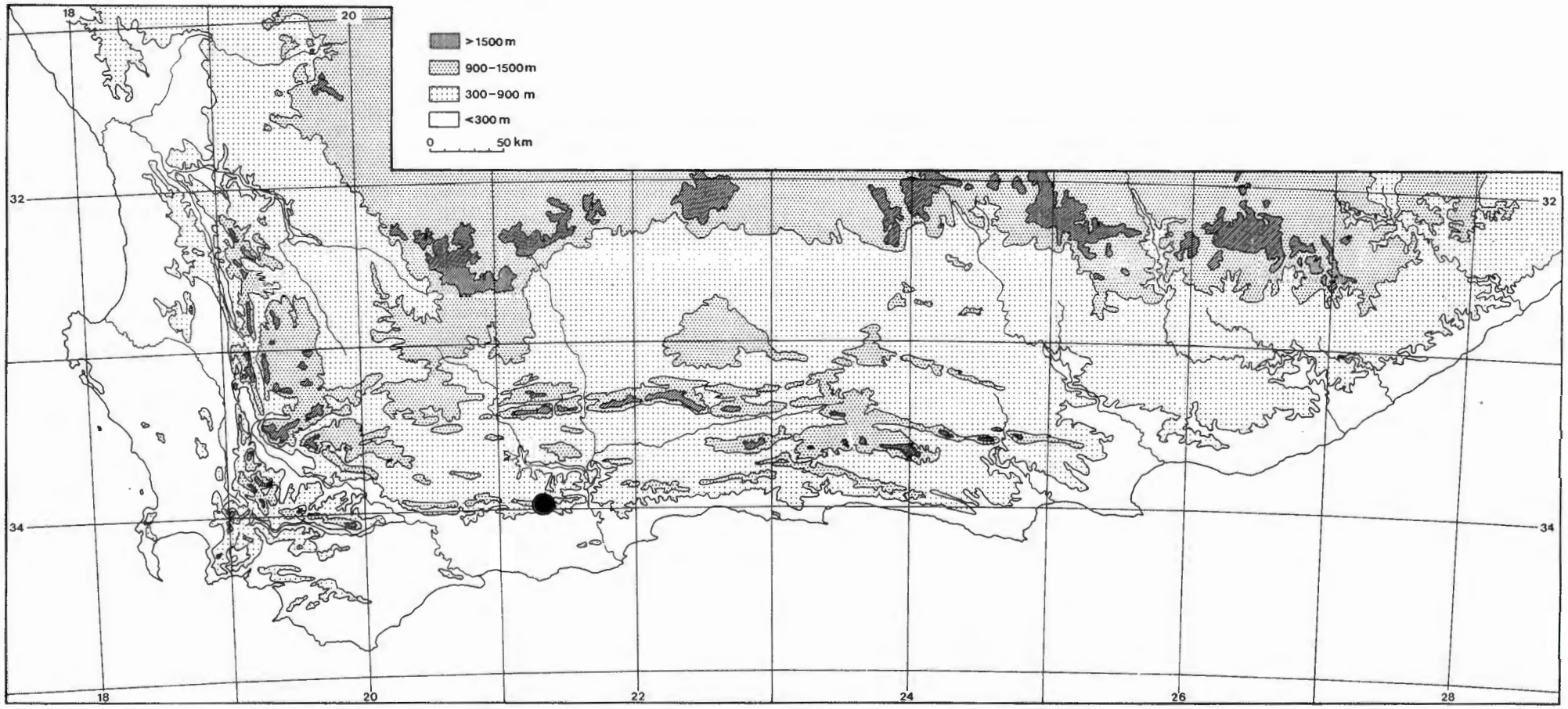


Fig. 9.32 Known distribution of *Otholobium saxosum* C.H. Stirton in southern Africa.

Otholobium saxosum is a rare endemic of the Langeberg Mountains (Fig. 9.32) and is poorly represented in herbaria. It inhabits the early successional stages of mountain fynbos growing on Table Mountain Sandstone. It seems to coppice after fires. Flowering takes place in October and November. It occurs at about 600 m altitude.

O. saxosum was previously referred to *O. polyphyllum* but differs from that species in its small decumbent habit, obovate leaflets, elliptic standard, scarcely fused-vexillar calyx teeth, and narrowly lanceolate flower bract. It can be separated from *O. bowieanum* by its elliptic standard, free vexillar teeth and different inflorescence structure.

The Latin specific epithet *saxosum* means rocky or stony and alludes to the type of area in which the species grows.

Species examined

-3321 (Ladismith): Garcias Pass (--CC), 10-11-1986, *Stirton & Zantovska 11546* (K, NBG); 10-1904, *Bolus 11264* (BOL, K, NH, PRE).

14. Otholobium acuminatum (Lam.) C.H. Stirton in S. Afr. J. Bot. 52: 2 (1986). Gibbs Russell et al., Mem. Bot. Surv. S. Afr. 56: 88 (1987).

Psoralea acuminata Lam., Encycl. 3: 173 (1789); Poiret, Tabl. Encycl., 3: 614, t.2 (1794); Eckl. & Zeyh., Enum. 229 (1836). Neotype: Wit Els Bosch flats, 750 ped., October 1920, *Fourcade 937* (BOL). I have been unable to trace the specimen/s on which Lamarck based this species. The protologue is most descriptive so it has been easy to establish a neotyope. In the past this species has been misinterpreted by most authors who confused it with *P. bracteolata* Eckl. & Zeyh. under the names *P. bracteata* L. or *P. fruticans* (L.) Druce.

P. densa E. Mey., Comm. 86 (1836). Lectotype: "Kaymansgat, IV C b, Alt. 500 ped., (George)", *Drège* s.n. (K, lecto; G, L, MO, iso). The right hand specimen of the Kew sheet is chosen as the lectotype.

Erect shrub, 1 -- 2 m tall, branches spreading in upper parts, sparsely sericeous. **Leaves** digitately trifoliolate, scarcely petiolate. **Leaflets** 7 -- 10 mm long, 7 -- 10 mm wide, broadly obovate to very broadly obovate, apex emarginate; sharply recurved mucronate, mucro up to 1 mm long; base obtuse to cuneate, patent; distinctly nigropunctate when dried, glands more or less equal in number on both surfaces; margin smooth, immature leaves glabrous; petiole 1 mm long, shorter than stipules; petiolules 1 mm long, sericeous. **Stipules** 2,0 -- 2,5 mm long, 1 mm wide, ciliate, persistent, longer than petioles, broadly oblique ovate. **Inflorescences** usually solitary in terminal axils of short shoots, sometimes with a second in the same axil, transversely broadly elliptic to broadly ovate, 15 mm long, 20 -- 25 mm wide, comprised of 15 -- 16 triplets of pedicellate flowers; pedicels 2 -- 3 mm long; each triplet subtended by a 4 mm long, 1,8 -- 2,0 mm wide, lanceolate, naviculate, persistent, glandular bract with blackish hairs along the

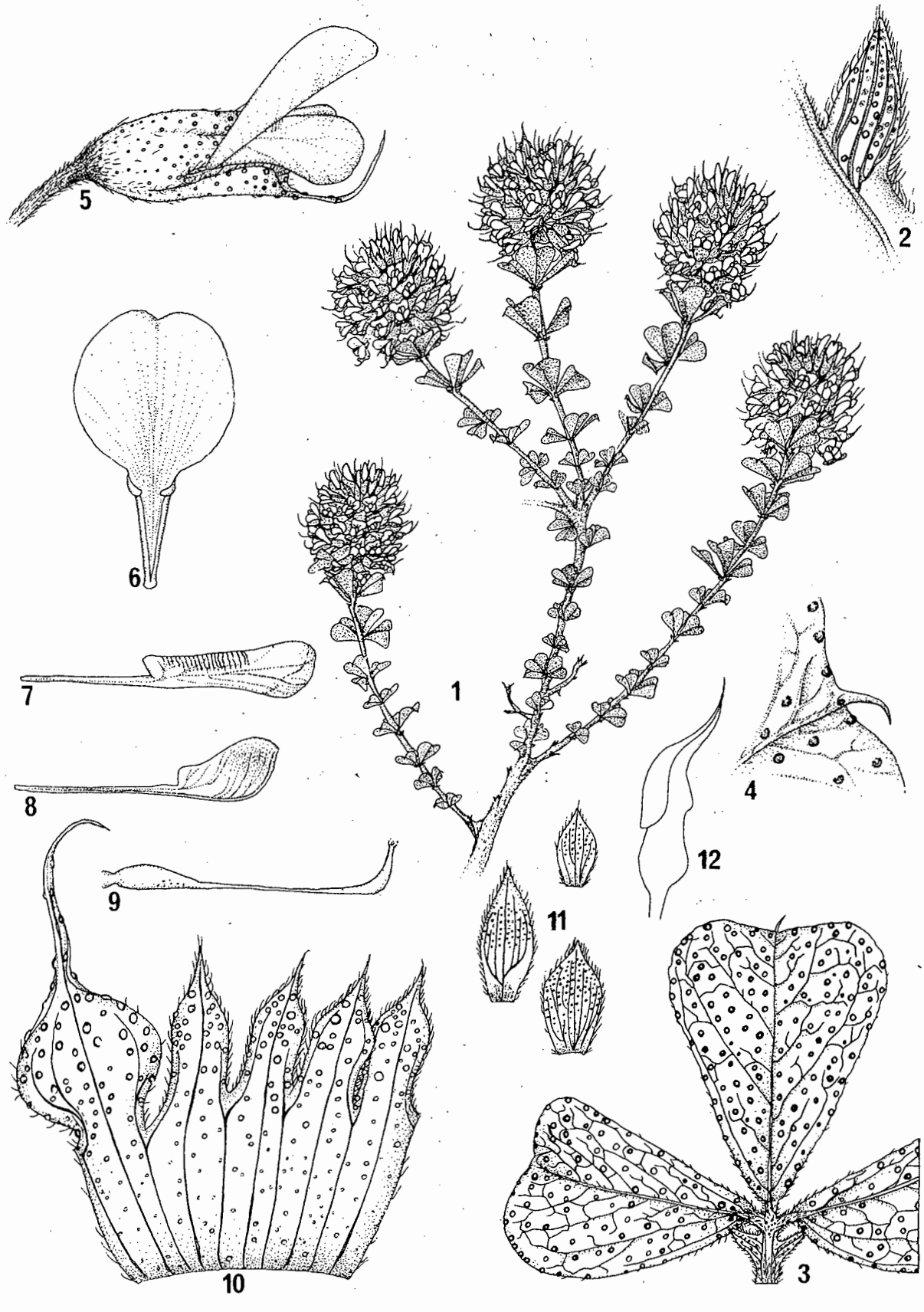


Fig. 9.33 *Otholobium acuminatum*. 1, Flowering shoots, x1; 2, Stipule, x8; 3, Digitately trifoliolate leaflet, terminal showing upper face, laterals lower faces, x7; 4, Apex of terminal leaflet, x 14; 5, Side view of flower just after anthesis, x6; 6, Standard upper face x 6; 7, Wing petal, x6; 8, Keel petal, x6; 9, Pistil, x7; 10, Calyx opened out, inner face, x11; 11, Triplet bracts, the largest bracts subtend the basal triplets, the smaller ones the upper triplets, x6; 12, Flower bud, x3 (*Burchell 6004*).

margin and towards the base; peduncle < 5 mm long. **Flowers** 7 -- 8 mm long, purple, ebracteate. **Calyx lobes** unequal, lateral and vexillar lobes equal, carinal lobe 8 mm long, 3 mm wide, longer and much broader than others, apex of lobe acuminate to coiled, teeth densely glandular, more so than on the tube; all teeth except the carinal tooth shorter than the 3 -- 4 mm long tube, vexillar lobes fused higher than rest; glabrous except for a few short black hairs along the margins of the teeth. **Standard** 7 mm long, 4,0 -- 4,5 mm wide, obovate, auriculate; claw prominent, 3 mm long; apex emarginate, glabrous; dark bluish mauve with a reddish purple nectar patch halfway between the claws and the apex. **Wing petals** 7 mm long, 3,5 mm wide, mauve, overlapping; claw 4 mm long; longer than petals; sculpturing upper central, upper basal merging towards upper distal, comprised of more than 30 irregularly arranged lamellae, rows indistinct. **Keel petals** 6 mm long, blade 2,5 mm long, 1,5 mm wide, claw 4 mm long. **Androecium** 6 mm long, vexillar stamen fused towards the base, sheath split adaxially; anthers 0,3 mm long, equal. **Pistil** 7 mm long; ovary 1,5 mm long, glabrous, with scattered glands; height of curvature 1,5 mm high, style thin but thickened at flexure; stigma papillose. **Fruits** and seeds unknown. Fig. 9.33.

Otholobium acuminatum occurs in or near damp places in coastal and montane fynbos (Fig. 9.34). It occurs at altitudes between 275 m and 500 m. Flowering takes place from September to November, with a peak in October.

Keet 247 has a note which states that the whole plant is used for smoking fish and bacon. The flowers of this species produce a sweet aroma. Cut stems of this very attractive plant lasted five to six days in water. This species has great potential as a horticultural species and as a cut-flower.

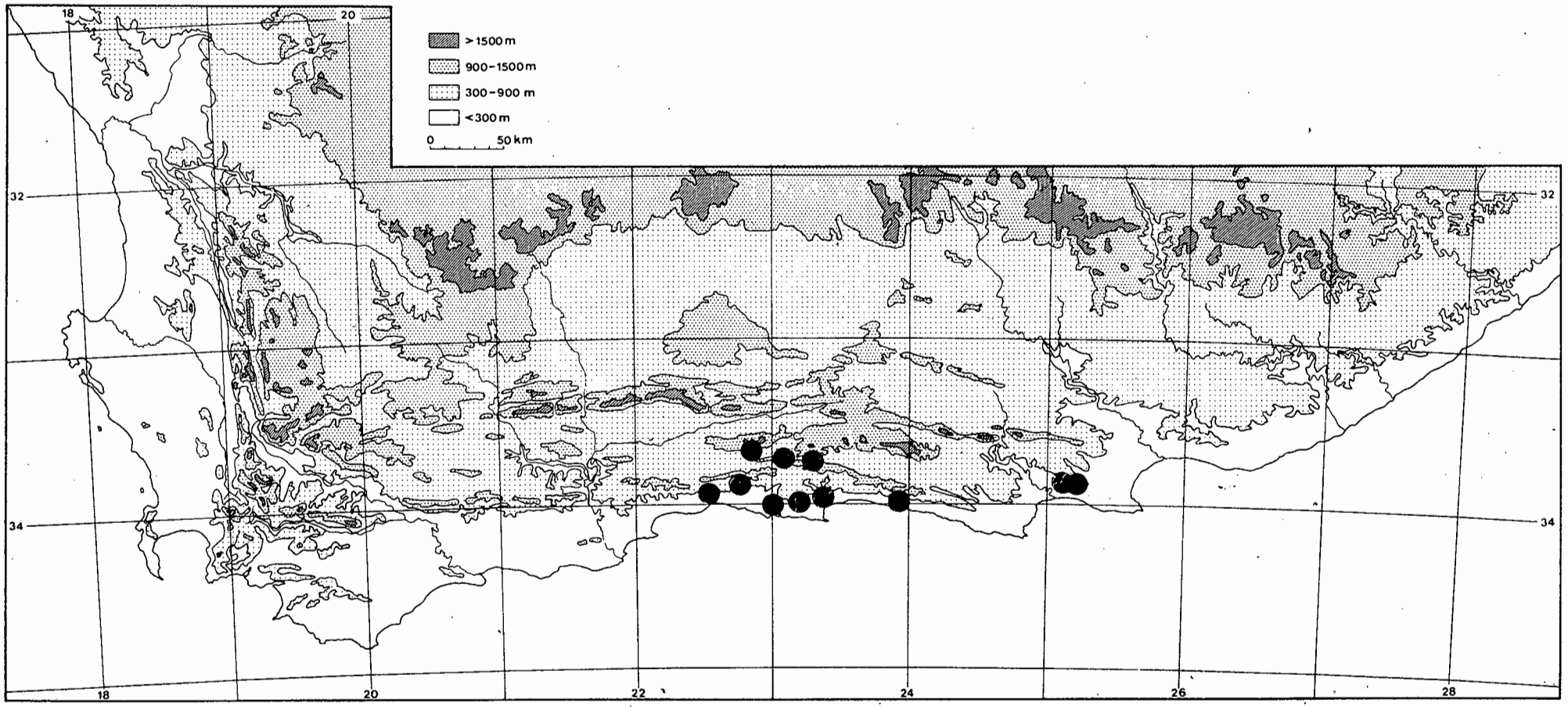


Fig. 9.34 Known distribution of *Otholobium acuminatum* (Lam.) C.H. Stirton in southern Africa.

O. acuminatum has been confused in the past with *O. stachyerum*. These species may be separated as follows:

1. Leaves subsessile; branches vestiture comprised of yellowish hairs; left half of lateral leaflets wider; flowers maturing more or less simultaneously; calyx tube longer than calyx teeth..... *O. acuminatum*

1. Leaves petiolate; branches vestiture comprised of white to silvery hairs; right half of lateral leaf wider; flowers maturing sequentially; calyx tube shorter than calyx teeth ..... *O. stachyerum*

Specimens examined

-3322 (Oudtshoorn): near George (--CD), 15-9-1815, *Burchell 6004* (K); 9-1847, *Alexander Prior* s.n. (K); 10-1905, *Hops* s.n. (BOL); *Schlechter 5863* (K, PRE, STE, Z); 14-11-1986, *Stirton & Zantovska 11624* (K, MO, NBG, STE); lower slopes of Kammanassie mountains (--DB), 10-1-1977, *Bond 841* (PRE, SAAS); Kaymansgat (--DC), *Drège* s.n. (GBH, K, S); Saasveld (--DC), 15-6-1972, *Morze 2245* (PRE, SAAS); Keureboomsrivier (--DD), *Drège* s.n. (K).

-3323 (Willowmore): Lauterwater (--CA), 17-11-1934, *Compton 4873* (NBG); Witte Els Bosch (--CD), 10-1920, *Fourcade 937* (BOL, US); dunelands between Kromme and Tzitzikamma Rivers (--DD), 10-11-1921, *Forestry Department 71* (GRA).

-3325 (Port Elizabeth): Van Stadens Mountains (--CC), 10-1866, *Toynbee* s.n. (K); *Zeyher 2376* (GRA, SAM, STE).

-3423 (Knysna): Kranskop West Station (-AA), 9-1960, *Horn* s.n. (PRE); mountains near Plettenburg Bay (-AB), *Zeyher* s.n. (GRA, SAM).

Without precise locality: Concordia Plantation, 9-1919, *Keet 247* (GRA, PRE); *Mund* s.n. (SAM); *Thom 489* (K); 11-1949, *Stokoe* s.n. (SAM 61585).

15. Otholobium heterosepalum (Fourcade) C.H. Stirton in S. Afr. J. Bot. 52: 3 (1986).

Psoralea heterosepalum Fourcade in Trans. Roy. S. Afr. 21: 95 (1932). Lectotype: The Heights, *Fourcade* 4225 (BOL). The sheet in Fourcade's herbarium is a mixed gathering. The right hand specimen is a good match of the protologue and is here designated the lectotype. This specimen matches the two duplicates in BOL. The left hand specimen of *Fourcade 4225* in Fourcade's herbarium is *Otholobium prodiens* C. H. Stirton.

Erect shrub 1,8 -- 2,5 m tall; coppicing after fires. **Stems** virgate, puberulous. **Leaves** digitately trifoliolate, clasping, scarcely petiolate. **Leaflets** unequal; terminal longest, (8) 10 -- 12 (15) mm long, 3 -- 6 mm wide; laterals unequal-sided, upper margin straight, lower convex; midribs prominent, apex mucronate, mucro straight, base acute; stem leaflets much larger than those borne on flowering shoots, younger leaves thinly villous on midrib, ciliate, the older glabrescent, glands equal in number on both surfaces, impressed; petioles <2 mm long, petiolule <1 mm long. **Stipules** triangular, 2 -- 3 mm long, scarious, striate, ciliate. **Inflorescences** pedunculate, axillary, borne in upper axils of short seasonal 40 -- 140 mm long shoots; comprised of a triplet of pedicellate flowers, each triplet subtended by a broadly lanceolate, 2 -- 3 mm long, scarious, striate, ciliate bract; peduncle shorter than pedicels. **Flowers** 7 -- 10 mm long, corolla shorter than and concealed by carinal lobe of the calyx; dull white, suffused with mauve, pedicels 1 mm long, flower bract cucullate, narrowly lanceolate. **Calyx** slightly longer than the corolla, 7 -- 8 mm long; tube 1,5 -- 2 mm long, carinal lobe much longer and broader than the other lobes, 7 -- 8 mm long, 4 -- 5 mm long, tooth ovate-cuspidate; laterals and vexillar teeth deltoid-lanceolate, spreading, more or less equal to the tube; strongly ribbed, secondary veins thickened; villous or glabrate, glands prominent all over the calyx but

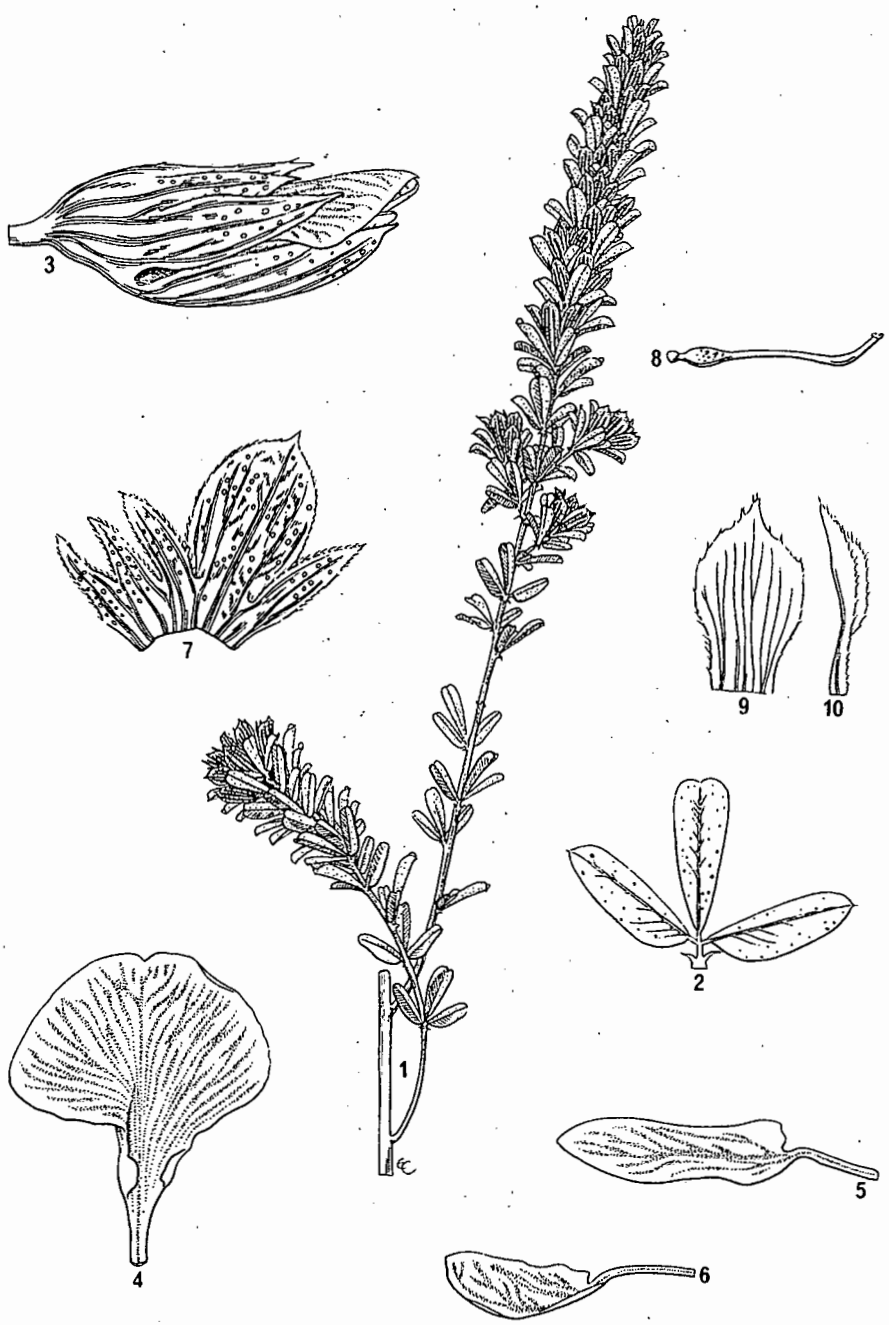


Fig. 9.35 *Otholobium heterosepalum*. 1, Flowering shoots, $x^2/_3$; 2, Digitately trifoliolate leaflet , x1,5; 3, Side view of flower, x5; 4, Standard, x6; 5, Wing petal, x6; 6, Keel petal, x6; 7, Calyx opened out, inner face, x3; 8, Pistil, x6; 9, Triplet bracts, x14; 10, Flower bract, x14 (*Fourcade 4225*).

denser on the teeth, markedly accrescent at onset of fruiting. **Standard** 6,0 -- 6,5 mm long, 4,0 -- 4,5 mm long, claw 1,5 -- 2,0 mm long, broadly elliptic, white with broad purple nectar guide, auriculate. **Wing petals** 5,5 -- 6,5 mm long, 2 mm wide, claw 2 mm long, auricle scarcely developed; longer than keel petals, sculpturing well-developed, thick, upper basal and upper central, comprising 1 -- 2 rows of up to 17 transcostal lamellae; surface rugose, veins thick, coarse. **Keel petels** 5 mm long, 2 mm wide, claw 2,75 mm long. **Androecium** 4,5 mm long, vexillar stamen lightly fused to middle part on left hand edge of the adaxially split sheath. **Pistil** 4 mm long; ovary <1mm long, stipitate, glandular; style thickened maximally at point of flexure, height of curvature 1,2 mm, erect to forward sloping; stigma capitate, papillose. **Fruits** and seeds unknown. Fig. 9.35.

Otholobium heterosepalum occurs in Acocks's False Macchia (Veld Type 70) on the Tsitsikamma, Suuranys and Kareedouw Mountains between 400 -- 600 altitude (Fig. 9.36). It coppices readily after fires and is often found in large stands. Flowering takes place from September to December with peaks in October and November.

O. hetersepalum is related to *O. carneum*, *O. prodiens*, *O. polyphyllum* and *O. bowieanum*. It differs from these species in its large ovate-cuspidate carinal tooth of the calyx which is much larger than the other four teeth, and in the corolla which is almost enclosed within the calyx.

Specimens examined

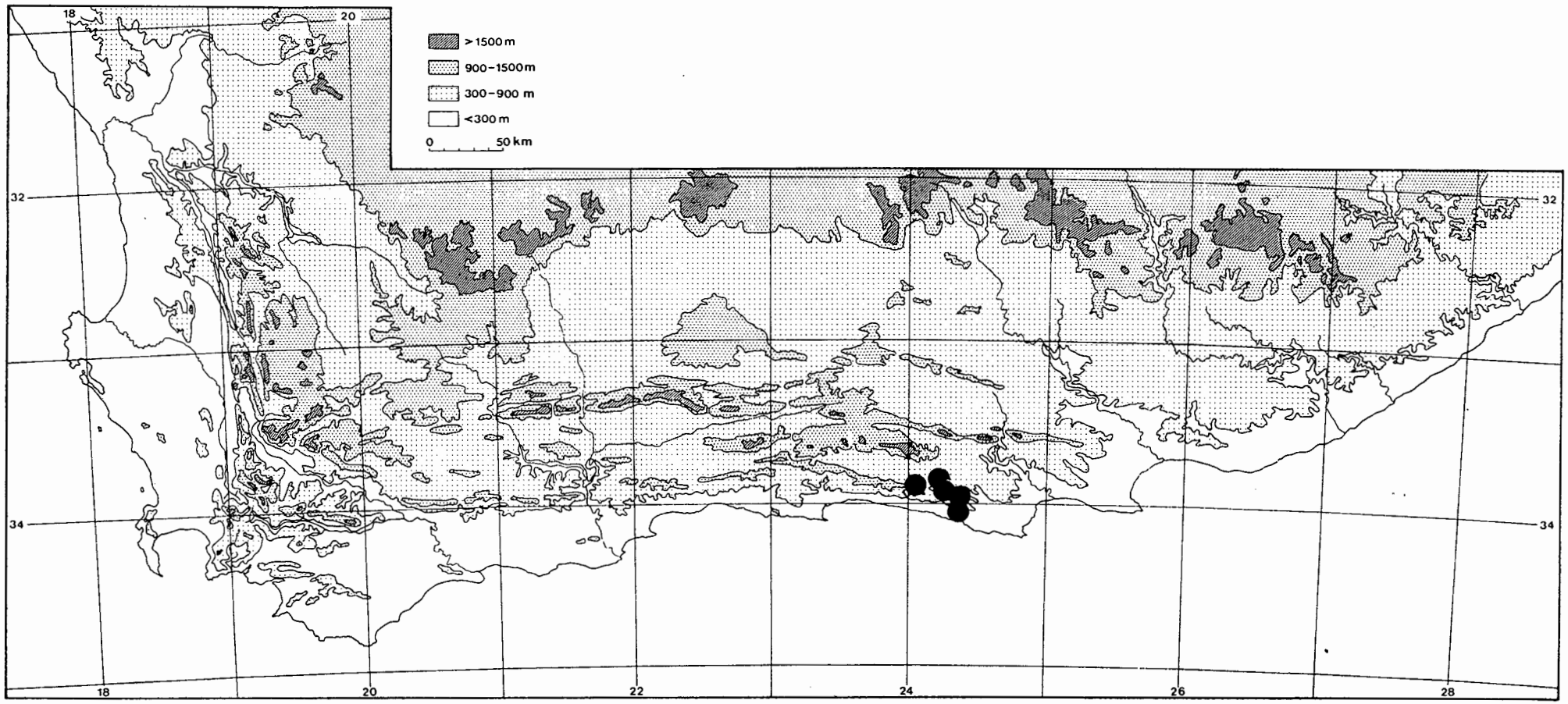


Fig. 9.36 Known distribution of *Otholobium heterosepalum* (Fourcade) C.H. Stirton in southern Africa.

-3324 (Steytlerville): Die Hoek, N side of Outeniqua Mountains (--CC), 5-11-1944, *Esterhuysen 10635* (BOL); Suuranys Hills, top of Kareedouw Pass (--CD), 17-10-1985, *Vlok 1210* (K, NBG, PRE, SAAS); 8-9-1973, *Thompson 1816* (STE); 28-10-1961, *Rycroft 2333* (NBG, STE); 21-12-1923, *Compton 4555* (BOL, NBG).

-3424 (Humansdorp): Clarkson (--AB), 6-1926, *Thode A806* (K, NH, PRE); 17-11-1984, *Schlechter 6012* (BOL); 13-9-1987, *Galpin 3961b* (BOL, GRA, PRE); 11-1927, *Fourcade* s.n. (STE); The Heights (--CD), 12-1928, *Fourcade 4225* (BOL); Humansdorp (--BB), *West 91* (K).

16. Otholobium carneum (E.Mey.) C.H. Stirton in J. S. Afr. Bot. 52: 2 (1986).

Psoralea carnea E. Mey., Comm. 85 (1836); Harv. in Harv. & Sond., Fl. Cap. 2: 149 (1862); Forbes in Bothalia 3: 131, pro parte (1930). Lectotype: The exact locality is uncertain, said to have come from the area between Piquetberg and False Bay but as the species is restricted to the Kouga Mountains Meyer was correct in casting some doubt on its provenance. Collector: *Drège* 314 (MO, lecto; G, K, fragment, W, iso). The available type material of this species is rather depauperate and it was only after I had seen the MO sheet that I was able to determine unequivocably that what I had been referring to as *O. oriens* C. H. Stirton mss was *O. carneum* and not an undescribed species. The first material that I studied was returned with determinavits bearing the name *O. oriens* and so should be corrected accordingly.

Small, erect, deciduous, much branched shrubs. **Branchlets** terete, slender, glabrate. **Leaves** digitately trifoliolate, shortly petiolate, shiny. **Leaflets** 8 -- 12 mm long, 1,5 -- 2,0 mm wide, terminal leaflet somewhat longer; very narrowly obovate to oblong, laterals assymetrical, conduplicate, subsessile, base cuneate, apex recurved mucronate, glands not clearly visible, hyaline. **Stipules** 1,5 -- 1,7 mm long, fused for the length of the petiole and adnate to it, triangular, patent but recurving with maturity, prominently veined, persistent. **Inflorescences** borne on short shoots, axillary, comprising a single triplet of flowers subtended by a 3,5 -- 3,7 mm long, 1,5 -- 1,8 mm wide, pandurate, ciliate, prominently veined bract with irregular apex; the common peduncle has a solitary 1,7 mm long, narrowly falcate bract inserted just below the common flower bract. **Flowers** 7 -- 8 mm long; pedicel 2,0 -- 2,3 mm long; peduncle 1 -- 2 mm long. **Calyx** equal to or longer than the corolla, 8 -- 9 mm long; lateral and vexillar lobes more or less equal but shorter and much narrower than the keel lobe; vexillar teeth 1,0 -- 1,5 mm

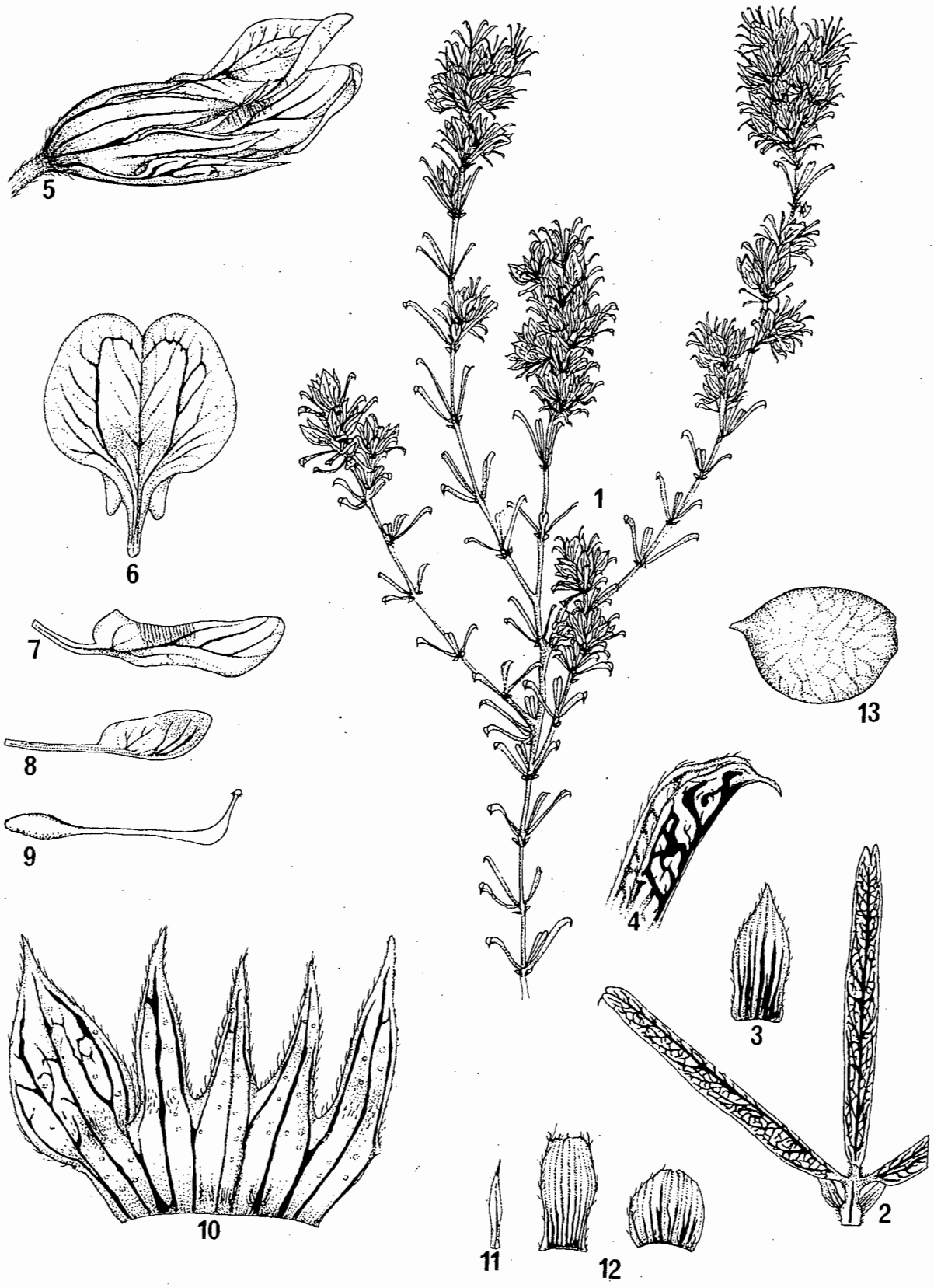


Fig. 9.37 *Otholobium carneum*. 1, Flowering branch, x1; 2, Digitately trifoliolate leaflet, x5,5; 3, Stipule, x10; 4, Apex of terminal leaflet, x8; 5, Side view of flower at anthesis, x8; 6, Standard, inner face, x7; 7, Wing petal, x7; 8, Keel petal, x7; 9, Pistil, x10; 10, Calyx opened out, inner face, x9; 11, Peduncle bract, x10; 12, Triplet bracts, showing variation in shape, x10; 13, Fruit, x7 (*Esterhuysen 6992*).

wide, fused slightly above the tube; sparsely pubescent, margins appressed pubescent; veins raised, very prominent. **Standard** 5,0 -- 5,5 mm long, 4 mm wide, very broadly ovate, scarcely auriculate, appendages absent; claw 1,5 -- 2,0 mm long. **Wing petals** I6 mm long, 1,5 -- 2,0 mm wide, auriculate; sculpturing present, upper basal and upper central comprised of up to 20 parallel, transcostal lamellae, rows indistinct. **Keel petals** 4,3 -- 4,5 mm long, 1,3 -- 1,6 mm wide, blade bulging, apex rounded; claw 2 mm long. **Androecium** 3,6 -- 3,7 mm long, sheath split adaxially, tenth stamen free. **Pistil** 4 mm long; ovary 1 mm long, glabrous, gynophore absent; height of curvature 1,3 mm; style glabrous, 0,3 mm thick at point of flexure; stigma prominent, capitate, penicillate. **Fruit** 4,5 mm long, 3 mm wide, beaked; papery, reticulate. **Seeds** 2,6 -- 2,7 mm long, 2,3 -- 2,5 mm wide, 1,5 mm thick; dark brown; hilum 0,5 mm long, flushed, very broadly ovate, rim aril present; micropyle deltoid, free from hilum. Fig. 9.37.

Otholobium carneum was first collected in 1830 by Drège. It has been collected twice only since then. It occurs on the Kouga and Baviaanskloof mountains (Fig. 9.38). We owe its rediscovery to Elsie Esterhuysen, the renowned plant collector, who has traversed the species rich Cape Mountains for so many years with so much success. The re-discovery of *O. carneum* stresses yet again the poor state of collecting along the inland mountains east of Uitenhage and north of the Keurbooms River.

Otholobium carneum was collected in fruit in late November and was found growing in false macchia. Nothing is known about the biology of this plant.

Forbes (1930), in her monograph of *Psoralea*, confused this species with a group of five species centred on *P. carnea*. I recognize these as *Otholobium prodiens* C. H. Stirton; *O. heterosepalum* (Fourcade) C. H. Stirton; *O. polyphyllum* (Eckl.& Zeyh.) C. H.

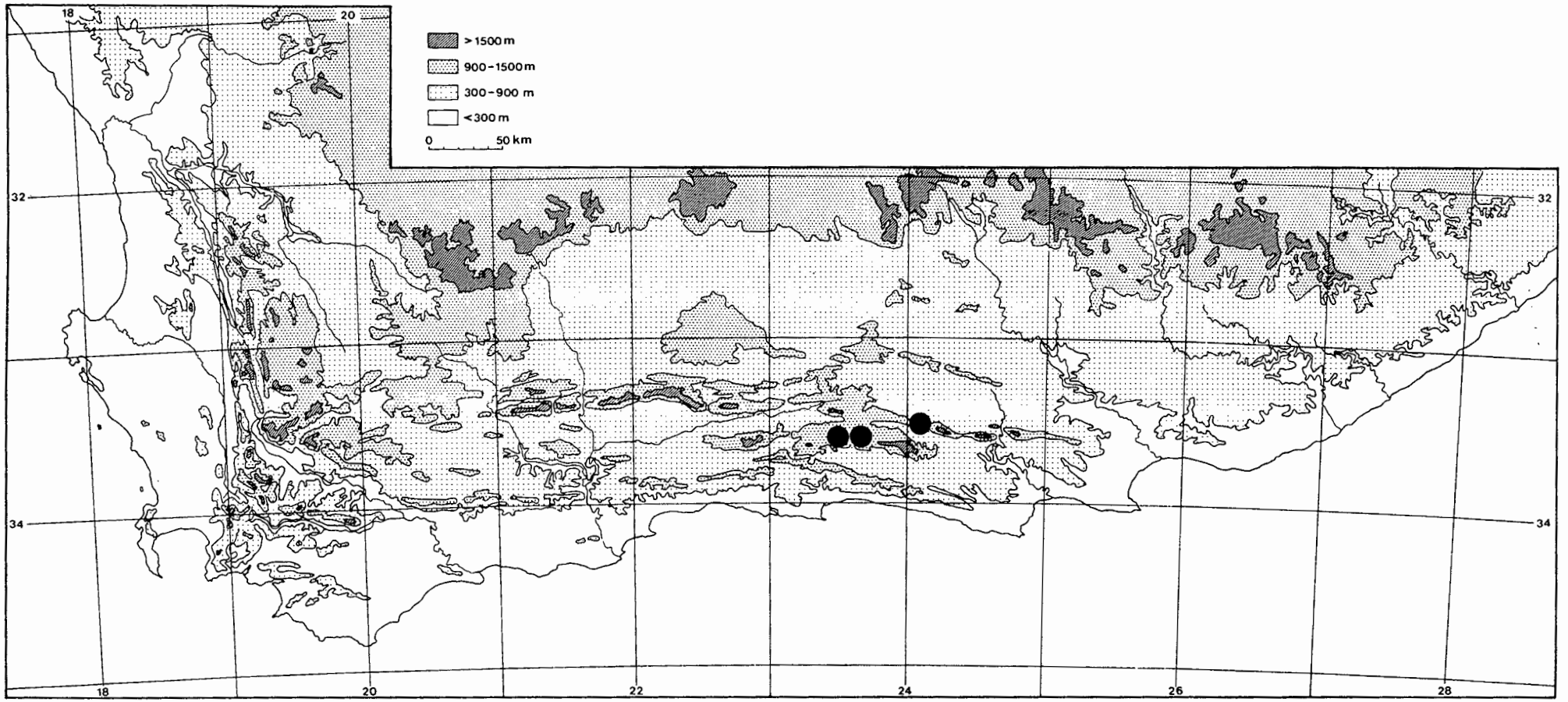


Fig. 9.38 Known distribution of *Otholobium carneum* (E. Mey.) C.H. Stirton in southern Africa.

Stirton; *O. stachyerum* (Eckl. & Zeyh.) C. H. Stirton and *O. acuminatum* (Lam.) C. H. Stirton. This species is readily separated from the above by its distinctively marked standard and narrowly obovate to oblong leaflets with thickened venation.

The diagnostic features are: Small compact deciduous shrub; leaflets conduplicate, glandular, glabrous, shiny, narrowly obovate to oblong inflorescences on short lateral shoots, 3-flowered; standard very broadly ovate; wing petals longer than keel petals; calyx teeth longer than the petals, carinal tooth twice as broad as the rest.

Specimens examined

-3323 (Willowmore): Peak east of Smutsberg, Kouga mountains (--DA), 27-11-1941, *Esterhuysen 6992* (BOL, K); lower slopes near Kouga Peak, 12-11-1944, *Esterhuysen 10187* (BOL).

-3324 (Steytlerville): Scholtzburg, Baviaanskloof (--CA), 17-5-1983, *Van Jaarsveld & Kotze 7753* (NBG).

Without precise locality: *Drège* s.n. (MO, K).

17. Otholobium polyphyllum (Eckl. & Zeyh.) C.H. Stirton in S. Afr. J. Bot. 52: 3 (1986).

Psoralea polyphylla Eckl. & Zeyh., Enum. 227 (1836); Walp. in Linnaea 13: 513 (1839); Walp., Repert. 1: 656 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 148 (1862); Forbes in Bothalia 3: 122 (1930). Lectotype: "In dunis prope nemora ante sylvas primaevas in Krakakamma (Uitenhage)", *Ecklon* s.n. (S, lecto; G, K, L, MEL 1542076, S, SAM 49205, TCD, iso).

Erect, much-branched leafy shrub up to 1 m tall. **Branches** short, pubescent. **Leaves** digitately trifoliolate, subsessile, stipulate. **Leaflets** subequal, erect, arching; terminal leaflet 8 -- 11 mm long 2,5 -- 4,0 mm wide, those on seasonal shoots much smaller, oblong to linear-oblong, somewhat longer than laterals, symmetrical; laterals unequal-sided, obliquely-oblong, somewhat gibbous; dark green, nitid, glabrous, initally with ciliate margins and adpressed on midribs; sparsely glandular, impressed, not easily visible; mucro pungent, straight to slightly curved, petiole 1,0 -- 1,5 mm long, petiolule 1 mm long. **Stipules** 2,0 -- 2,5 mm long, small, ovate-acuminate, reflexing, caducous. **Inflorescences** borne on very condensed leafy shoots, axillary, comprising a single triplet subtended by a persistent 2 mm long, 1,5 mm wide, oblong, multinerved, ciliate bract; peduncle absent or up to 1 mm. **Flowers** 6 -- 7 mm long, pedicel 1 -- 2 mm long, white, pedicels 2 -- 3 mm long, bract lanceolate 1 -- 2 mm long. **Calyx** slightly shorter than the corolla, lateral and vexillar lobes subequal but shorter and much narrower than the 6 mm long, 1,5 mm wide keel lobe; vexillar teeth fused for more than half their length above the 2 mm long tube; nigro-villous, prominently veined, carinal tooth ovate-lanceolate, others subulate, glands faintly visible, accrescent. **Standard** 5 -- 6 mm long, 4,5 -- 5,0 mm wide, claw 1,0 -- 1,5 mm long, pure white with a small bright purple nectar patch, veins greenish, broadly ovate, strongly auriculate. **Wing petals** 5 -- 6 mm long, 2

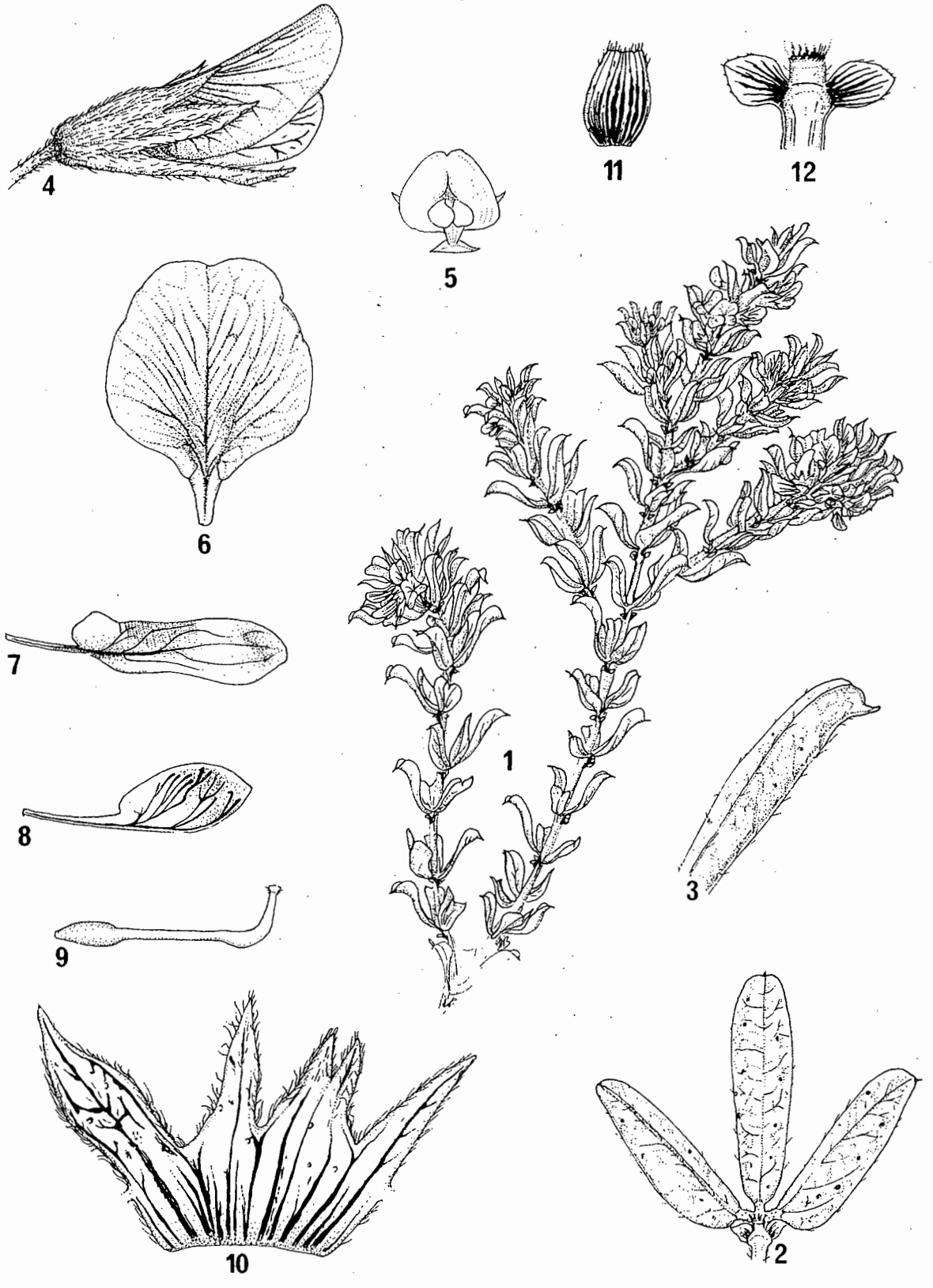


Fig. 9.39 *Otholobium polyphyllum*. 1, Flowering branches, x1; 2, Digitately trifoliolate leaflet, x4; 3, Apex of terminal leaflet, x6; 4, Flower, x7; 5, Flower, front view, x3; 6, Standard, inner face, x6; 7, Wing petal, x6; 8, Keel petal, x6; 9, Pistil, x10; 10. Calyx opened out, inner face, x10; 11, Triplet bract, x6; 12, Stipules, x8 (*Scharf 1392*).

mm wide, white, auriculate; sculpturing present, upper basal and upper central, comprised of 25 -- 35 parallel variously sized thick transcostal lamellae. **Keel petals** 3 -- 4 mm long, 2 mm wide, claw 2 -- 3 mm long, apex acute. **Androecium** 4 mm long, vexillar stamen free. **Pistil** 3,0 -- 3,3 mm long; ovary < 1 mm long, sparsely glandular, gynophore absent, height of curvature 1,5 mm, entasis well-developed, broadest before flexure, stigma capitate, penicillate. **Fruits** 3,0 -- 3,5 mm long, papery, reticulate. **Seeds** 2,5 mm long, mottled, khaki with black stripes and blotches. Fig. 9.39.

Otholobium polyphyllum is a little known and seldom collected species of Mesic Mountain Fynbos of the Elandsberg and Wintershoek Mountains of the south-eastern Cape (Fig. 9.40). Flowering takes place predominantly in July but has been recorded for the months of March, September and October. It occurs at 400 -- 600 m altitude.

O. polyphyllum has been confused in the past with *O. carneum* and *O. prodiens* but differs from those two species in its soft subequal, sparsely glandular leaves. From *O. carneum* it differs in its robust densely leafy habit, 2 -- 3 inflorescences clustered at the ends of seasonal shoots, pubescent branches, different leaf venation, and nigro-villous calyx with vexillar teeth fused for more than half their length. From *O. prodiens* it differs in its assymetrical, oblong to linear-oblong, lateral leaflets, white standard with bright purple nectar patch and greenish venation, and diadelphous androecium.

Specimens examined

-3324 (Steytlerville): Hankey Forest Reserve (--DB), 7-5-1979, *Cowling 280* (GRA).

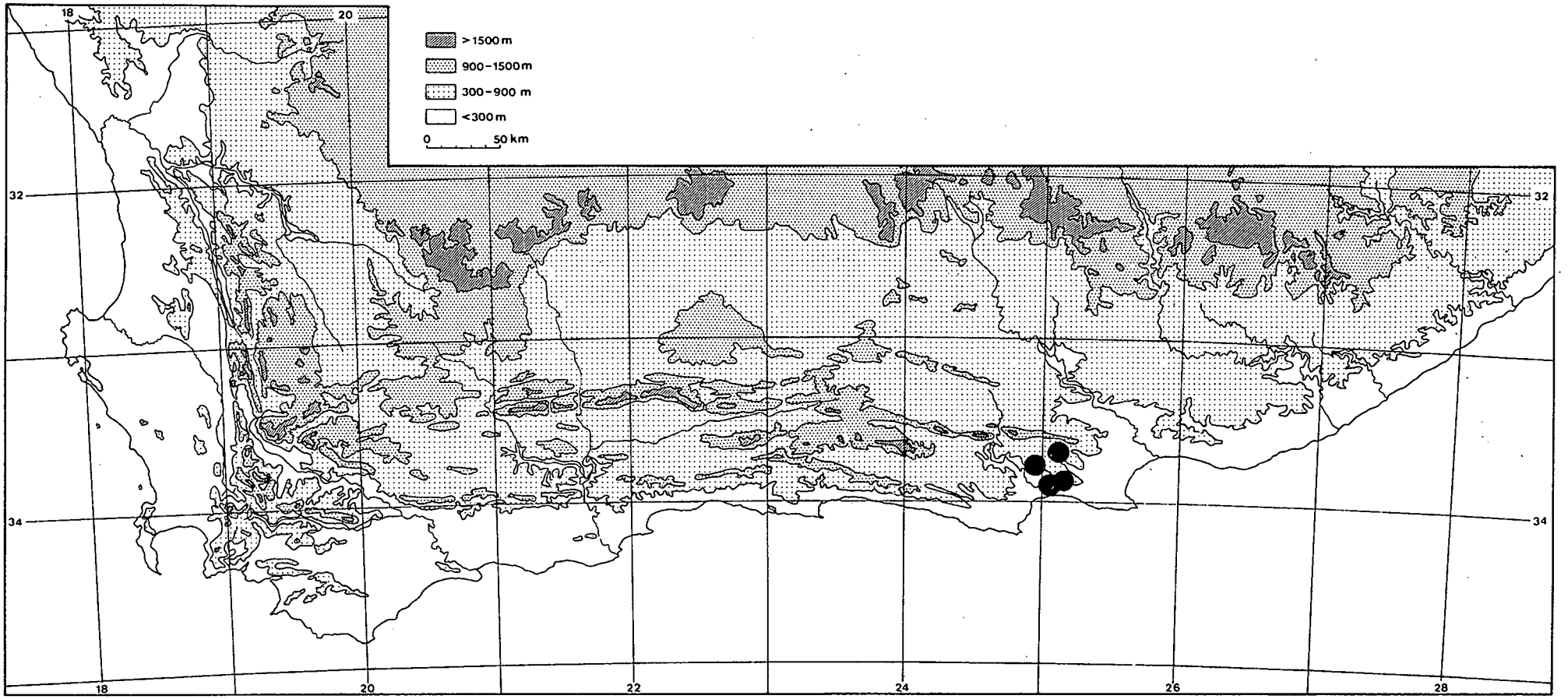


Fig. 9.40 Known distribution of *Otholobium polyphyllum* (Eckl. & Zeyh.) C.H. Stirton in southern Africa.

-3325 (Port Elizabeth): Riet Vley 344, Zunga Catchment Basin (--CA), 17-5-1974, *Scharf 1392* (PRE); Loerie Plantation (--CC), 27-10-1934, *Dix 134* (GRA); Longmore Forest Reserve (--CC), 1-9-1933, *Long 1033* (GRA, K); 13-11-1986, *Stirton & Zantovska 11601* (K); 15 miles up Elands River road (--CC), 31-5-1960, *Acocks 21064* (PRE); Krakakamma (--CD), *Ecklon & Zeyher 1536* (G, K, MEL); 3-1882, *Macowan* s.n. (K).

Without precise locality: *Verreaux* s.n. (G); Levskraal & Zonderrivier, 19-11-1984, *Penther 2476* (W).

18. Otholobium rotundifolium (L.f.) C.H. Stirton in S. Afr. J. Bot. 52: 4 (1986).

Psoralea rotundifolia L.f., Suppl. Pl. 338 (1782); Thunb., Prodr. 135 (1800); Fl. Cap. 605 (1823); DC., Prodr. 2: 218 (1825); Harv. in Harv. & Sond. 2: 155 (1862); Forbes in Bothalia 3: 129 (1930). Lectotype: "Habitat in Cap. Bonae Spei", *Thunberg* s.n. (UPS - Thunb. 17583, microfiche). There are no specimens of this species in LINN, S, or BM (Hort. Cliff.).

Small, densely leafy suffrutex up to 15 cm high, coppicing after fires. **Stems** numerous, 8 -- 15 cm long, branching in lower axils, erect, flattened, ribbed. **Rootstock** daucate. **Leaves** unifoliolate, basal leaves smallest. **Leaflets** 30 -- 35 mm long, 10 -18 mm wide, obovate, glabrous, weakly mucronate, base obtuse or acute, cuneate, densely nigro-punctate when dried, margin smooth, younger leaves glabrous; rib and veins prominent on both sides; rachis absent; petiole 2 -- 3 mm long, petiolules 0,5 mm long. **Stipules** 5 -- 7 mm long, 2 -- 3 mm wide, longer than the petioles of the basal axils, clavate, almost leafy, changing through subulate to linear in the upper axils, acute, glabrous. **Inflorescence** axillary, lax, oblong, 35 -- 50 mm long; comprised of 3 -- 5 triplets or duplets of pedicelled flowers; each set subtended by a persistent, flabellate, gland-dotted, hairy bract; peduncle 30 -- 60 mm long, 2x > length of leaflets. **Flowers** pale lilac to white, 10 -- 13 mm long, subtended by a 3 -- 5 mm long lanceolate, hairy and gland-dotted bract. **Calyx teeth** longer than the 3 mm long tube, unequal, four upper teeth curved, acute; carinal tooth broadest, 10 -- 12 mm long, 2,5 -- 3,5 mm wide; lateral lobes longer than vexillar lobes; dark green and covered in long patent silky white hairs; small glands scattered but prominent; glabrous on inner face of teeth. **Standard** 11 -- 13 mm long, 8 -- 10 mm wide, claw 3 mm long, broadly elliptic, pale mauve to white, appendages absent, auricles developed, claw narrowed; glabrous. **Wing petals** 12 -- 13 mm

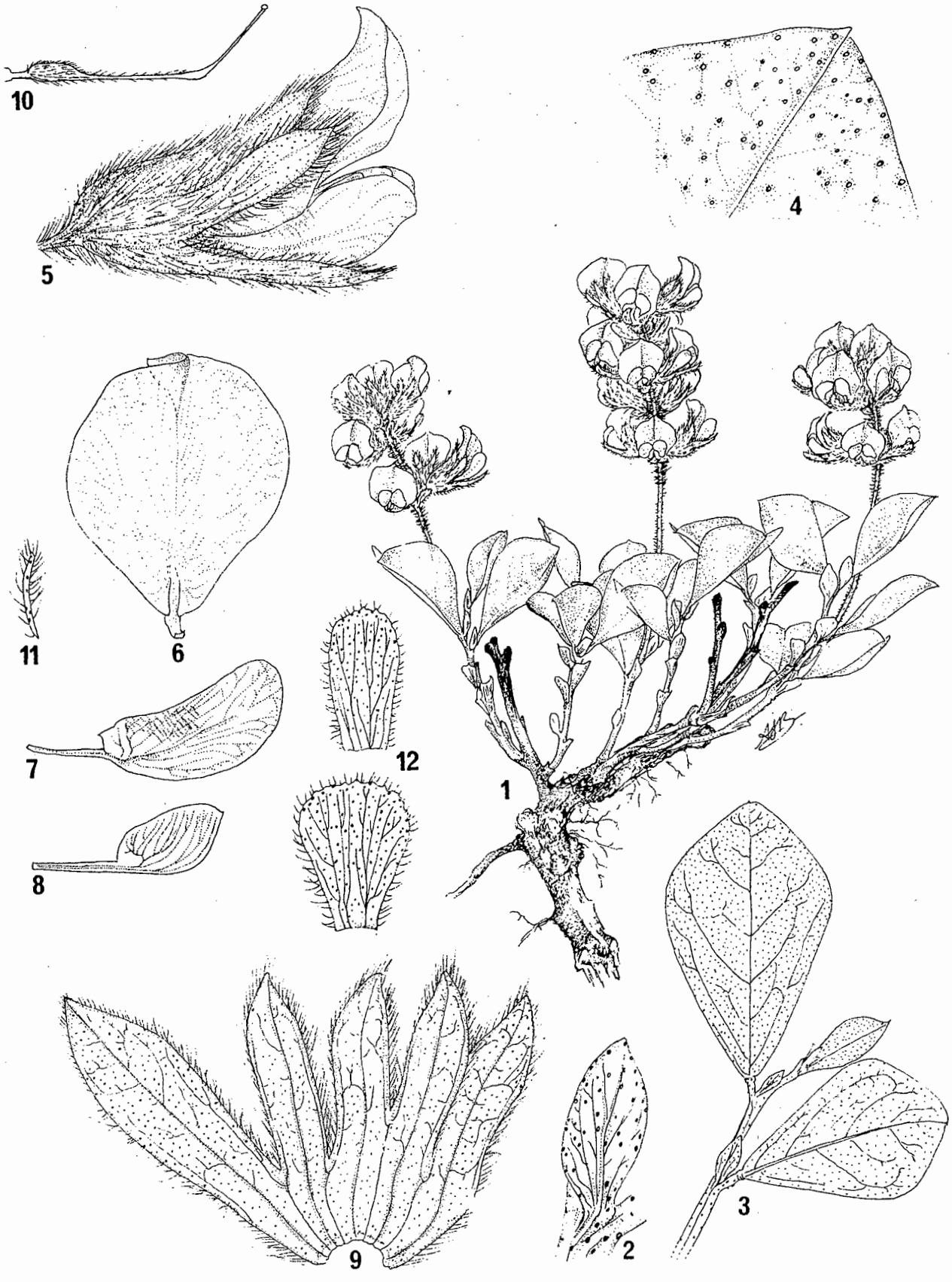


Fig. 9.41 *Otholobium rotundifolium*. 1, Habit, x1; 2, Stipule, x5; 3, Section of stem with unifoliolate leaflets, upper leaf shows upper surface view, lower leaf shows lower surface, x1,5; 4, Apex of terminal leaflet, x4; 5, Flower, x5,5; 6, Standard, x5; 7, Wing petal, x5; 8, Keel petal, x5; 9, Calyx opened out showing inner face, x5,5; 10, Pistil, x6; 11, Flower bract, x5; 12, Triplet bracts, x5 (*McDonald 857*).

long, 3 mm wide, cultrate, straight, auriculate, claw 4 -- 5 mm long; longer than keel petals; sculpturing upper central, comprised of up to 30 variously sized transcostal lamellae. **Keel petals** 8 mm long, 3 mm wide, 4 mm high, claw 4 mm long. **Androecium** 8 mm long, vexillar stamen free; anthers equal, 0,2 mm long. **Pistil** 7 -- 8 mm long; ovary 2 mm long, silky, height of curvature 3 mm, thickened at flexure; stigma somewhat penicillate. **Seeds** and fruits unknown. Fig. 94

Otholobium rotundifolium occurs in bare areas or in recently burnt veld and grows at an altitude of 130 -- 540 m in mountain fynbos. Flowering takes place from October to April with peaks between December and January.

O. rotundifolium is related to *O. accrescens* but differs in its dark green calyces covered in long patent white silky hairs, silky ovary, and inflorescences overtopping the scarcely petiolate leaves by 2 -- 3 times. In *O. accrescens* the calyx is glabrous except for a few blackish hairs along the margin, the ovary is covered in a few black prostrate hairs and the inflorescences greatly overtop the distinctly petiolate subtending leaves.

Specimens examined

-3318 (Cape Town): Jakkalsvlei (-DC), 14-1-1966, *Taylor 6666* (K, PRE, STE); Jonkershoek State Forest (-DD), 14-12-1966, *Grobbelaar 1332* (PRE); Swartboskloof (-DD), 24-11-1961, *van der Merwe 832* (PRE), *951* (PRE); *McDonald 857* (K, PRE, STE).

-3319 (Worcester): Zachariashoek (-CC), 10-1-1978, *van Wilgen 201* (STE).

-3418 (Simonstown): Kogelberg (-BD), 30-10-1975, *van Wilgen 39* (STE).

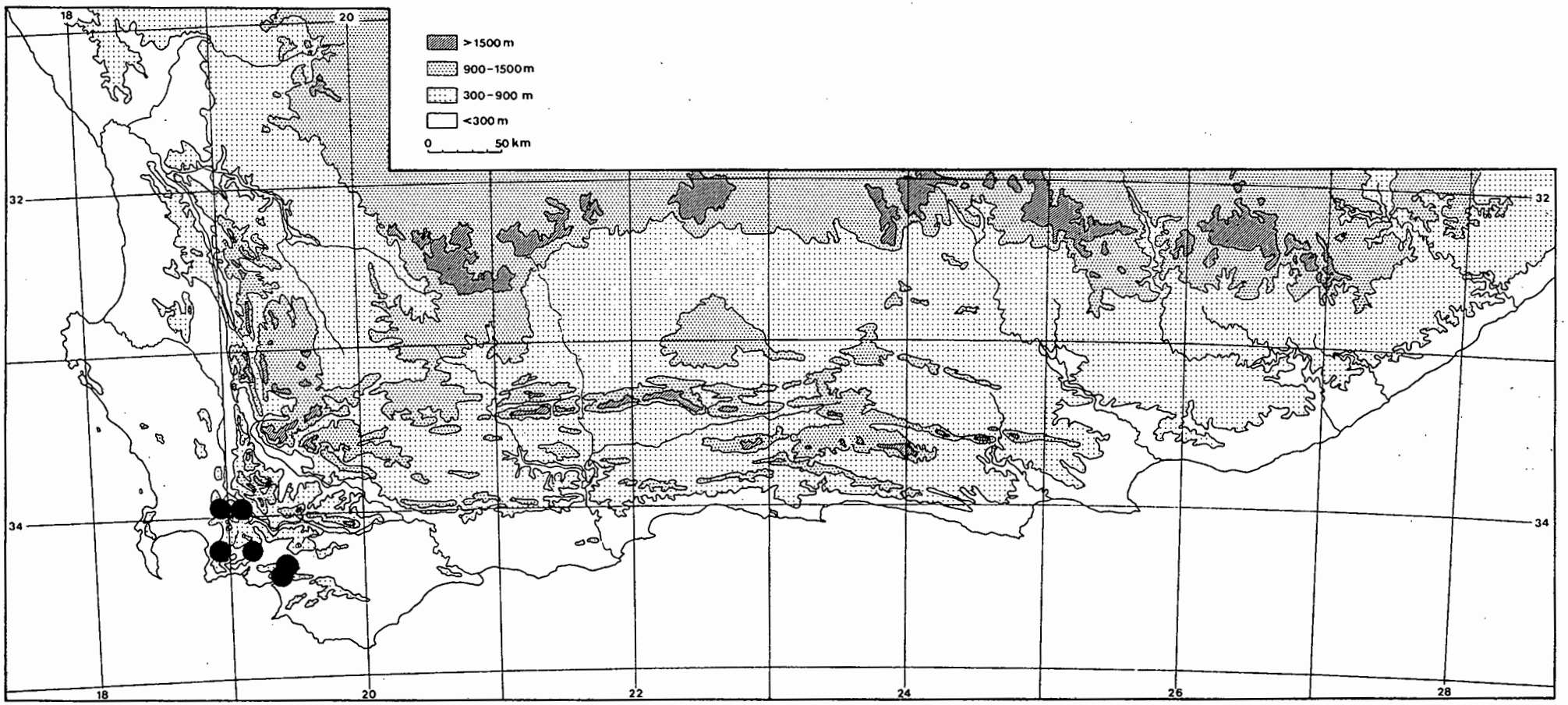


Fig. 9.42 Known distribution of *Otholobium rotundifolium* (L.f) C.H. Stirton in southern Africa.

-3419 (Caledon): Houw Hoek (-AA), 1897, *Bolus 80* (BOL); 4-1892, *Guthrie 2246* (BOL); Vogelgat (-AD), 2-12-1896, *Schlechter 4319* (PRE); 11-4-1897, *Schlechter 9574* (BOL, PRE); 11-4-1897, *Schlechter 10417* (BOL, G, L, PRE).

Without precise locality: "C.B.S." 1877, *Scholl* s.n. (K, MO, W).

19. Otholobium accrescens C.H. Stirton, *sp. nov.,* O. caffri *affinis sed calyce multo maiore, bracteis florum lanceolatis, pedunculo quam inflorescentias duplo vel triplo longiore et habitu rhizomatoso suffruticosoque differt.*

Typus: Otterford Forest Reserve (-CC), 31-9-1947, *Rodin 1128* (BOL, holo; GRA, K, MO, iso).

Suffrutex parvus erectus rhizomatosus usque 19 cm altus; post incendia novibus ramis e base orientibus. Caules 1 -- 3, ex rhizomato subterraneo et bene spatiosi orientes, in axilibus inferioribus ramosi, erecti, foliis basalibus minimus. Folia unifoliolata, 25 -- 40 mm longa, 15 -- 25 mm lata, late elliptica vel late obovata, glabra, vix mucronata, apice acuta base rotundata vel obtusa in sicco dense nigripunctata, margine laevi. Stipulae 4 -- 5 mm longae, 1,0 -- 2,5 mm late, quam petioli breviores, axilibus inferioribus aliquantum clavatae, in axilibus superioribus subulatae, in supremis lineares patentes vel recurvatae, glabrae. Inflorescentiae axillares ex axilibus basalibus orientes, laxae, 35 -- 55 mm longae, florium pedicellis 2 mm longis, floribus in gregibus 4 -- 7, trifloris aggregatis, grege omni a bractea late ovata sparse pilosa persistenti subtenta; pedunculus 70 -- 110 mm longus, quam folium a quo subtento quadruplo vel quintuplo longior. Flores 10 mm longi, omnes a bractea parva lineari subtenti; color ignotus. Calycis dentes quam tubus 3,0 -- 3,3 mm longus triplo longiores, aequales acuti; dens carinalis quam exteriores parum latior, 10 mm longus, 3 mm latus; lobi laterales vexillaresque lanceolati, tubum versus angustati, lobi vexillares quam aliis altiore connati; margine atro-pilosi, cetero glabri; venatione reticulato, glandulis frequentibus; accrescentes. Vexillum 11 mm longum, 3 mm latum, late ellipticum. Alae 11 mm longae, 2,5 mm latae, quam carina longiores. Petala carinae 8 mm longa, 4,5 mm lata. Androecium 8 mm longum; stamen decimum liberum. Pistillum 7 -- 8 mm longum; ovarium 2,5 mm longum, pilis atris prostratis pauces instructum, dense glandulosum, parte

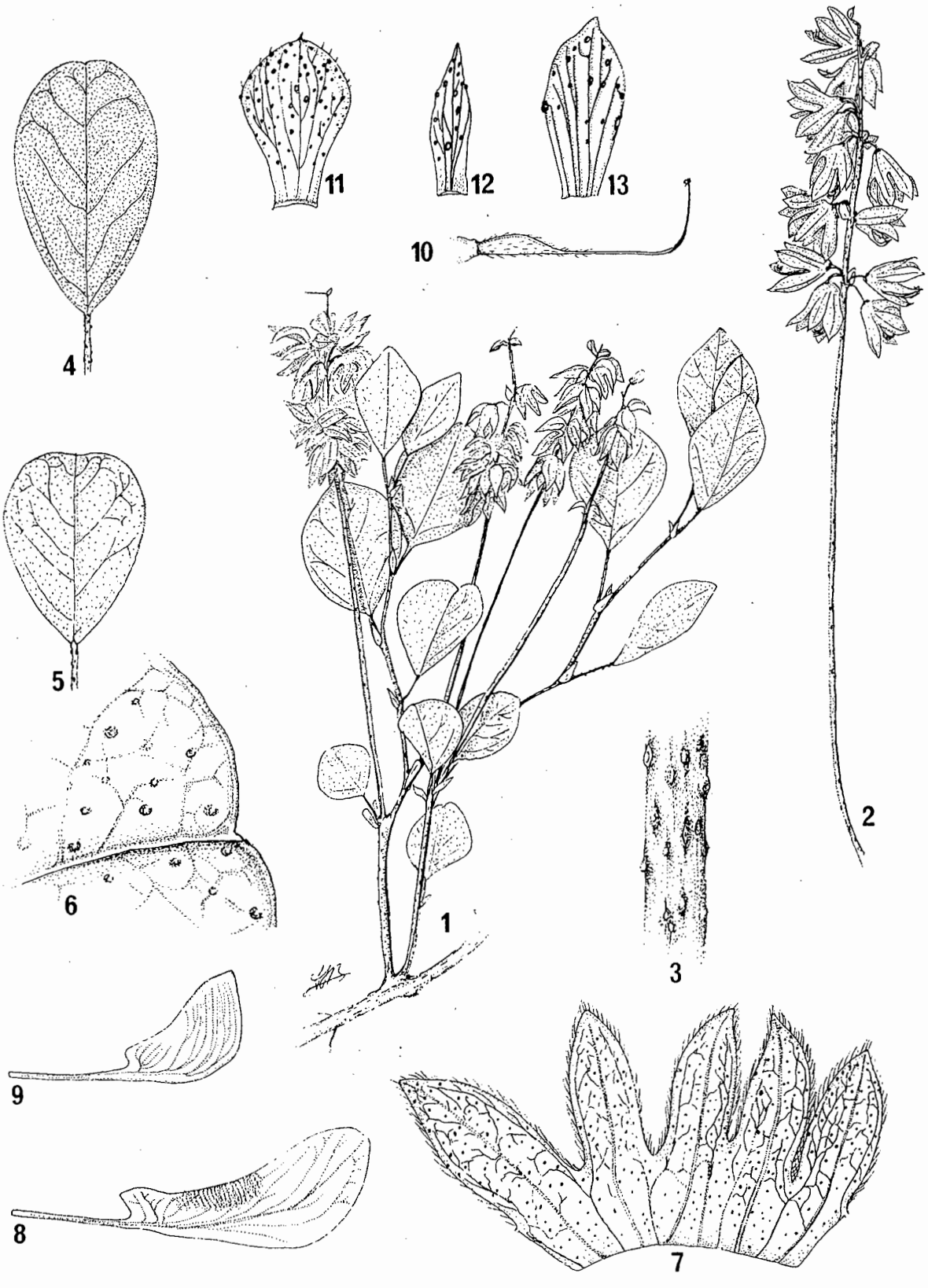


Fig. 9.43 *Otholobium accrescens*. 1, Flowering shoots arising from a portion of the underground rhizome (x0,5); 2, Infructescence x1; 3, Section of stem, x10; 4, Upper leaf surface, x1; 5, Lower leaf surface, note the variability in shape of this and the leaves shown in 4 and 1, the lower surface is less glandular, x1; 6, Apex of leaf, x5; 7, Calyx opened out, inner face, x4,5; 8, Wing petal, x5; 9, Keel petal, x5; 10, Pistil, x5; 11, Triplet bract, x5; 12, Stipule subtending leaves produced later in season, x5; 13, Stipule subtending leaves produced after fires, x5 (1, *Olivier 615*); 2-13, *Rodin 1128*).

curvata 2 -- 3 mm alta, ante partem curvatam incrassatum, stylo prorsus inclinato, stigma parvum, papillosum. Fructus dense glandulosus, 8 mm longus, 6,5 mm latus. Semina 5 mm longa, 4 mm lata, fusco-brunnea hilo protrudenti, centrali.

Small, erect, rhizomatous suffrutex up to 19 cm tall; coppicing after fires. **Stems** 1 -- 3, produced at intervals along an underground rhizome, branching in lower axils, erect, basal leaves smallest. **Leaves** unifoliolate, 25 -- 40 mm long, 15 -- 25 mm wide, broadly elliptic to broadly obovate, glabrous, scarcely mucronate, mucro arching, base acute, densely nigro-punctate when dried, glands denser on upper surface, margin smooth, younger leaves glabrous, veins prominent below and above; rachis absent; petiole 5 -- 8 mm long; petiolule 1 mm long. **Stipules** 4 -- 5 mm long, 1,0 -- 2,5 mm wide, shorter than petioles, somewhat clavate in lower axils through subulate to linear in upper axils, patent to recurved, glabrous, glandular. **Inflorescence** axillary in basal axils, lax, 35 -- 55 mm long, comprised of 4 -- 7 triplets of flowers borne on 2 mm long pedicels; each triplet subtended by a broadly ovate, sparsely hairy, persistent, papery bract; peduncle 70 -- 110 mm long, 4 -- 5 times length of subtending leaf. **Flowers** 10 mm long, colour unknown, each subtended by a small persistent linear bract. **Calyx teeth** 3 times longer than the 3,0 -- 3,3 mm long tube, equal, acute; carinal tooth slightly broader than other four teeth, 10 mm long, 3 mm wide; lateral and vexillar teeth lanceolate, narrowed towards tube; vexillar lobes fused higher up than rest; glabrous all over except for blackish hairs along the margin, venation reticulate; glands common, constant in size, equally distributed on teeth and tube; accrescent. **Standard** 11 mm long, 3 mm wide, claw 2 mm long, broadly elliptic, colour unknown, auriculate; claw narrowed. **Wing petals** 11 mm long, 2,5 mm wide, upcurving, overlapping, auriculate; claw 3 mm long, longer than keel petals; sculpturing upper right central, transcostal, comprised of up to 35 irregular lamellae, rows indistinct. **Keel petals** 8 mm long, 4,5 mm wide, 4,0 mm high; claw 4,5 mm long. **Androecium** 8 mm long; vexillar stamen free; anthers equal. **Pistil** 7 -- 8 mm

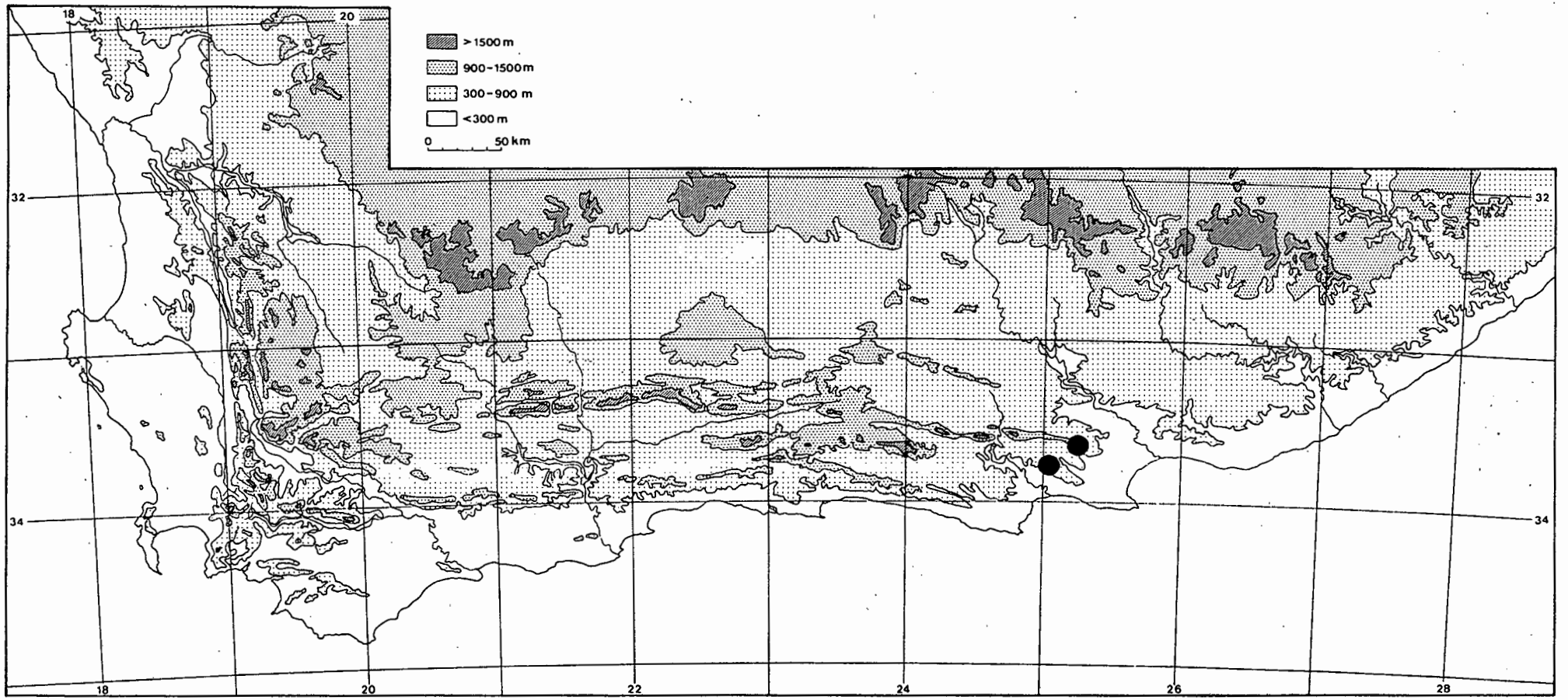


Fig. 9.44 Known distribution of *Otholobium accrescens* C.H. Stirton in southern Africa.

long; ovary 2,5 mm long, covered in black prostrate hairs, densely glandular, height of curvature 2 -- 3 mm long, thickened before flexure; style forward sloping; stigma small. **Fruit** densely glandular, 8 mm long, 6,5 mm wide. **Seed** 5 mm long, 4 mm wide, dark brown; hilum protruding, central. Fig. 9.43.

Otholobium accrescens has so far only been collected in the vicinity of the Otterford and Groendal Forest Reserves (Fig. 9.44) and is found at 550 -- 650 m altitude. It flowers from August to January.

This species is characterised by a combination of its rhizomatous habit, long petiolate unifoliolate leaves, calyx with fringed lobes, and densely glandular fruit. Vegetatively it resembles *O. caffrum* and *O. fumeum* but differs from these two species as follows:

1. Plant 10 to 60 cm tall; herbs; leaves unifoliolate, partly conduplicate; calyx about equal in length to corolla .*O. accrescens*.

1. Plant 150 cm tall or more; large shrubs; leaves 3-foliolate, displayed; calyx shorter than corolla.. 2.

    2. Lateral leaflets symmetrical, up to half the length of the terminal leaflet; stipules narrowly triangular; calyx tube equal in length to calyx teeth; style glabrous....*O. caffrum*.

    2. Lateral leaflets asymmetrical, half to two thirds the length of the terminal leaflet; stipules subulate; calyx tube shorter than calyx teeth; style hairy...*O. fumeum*.

Specimens examined

-3325 (Port Elizabeth): Ten Stop Hill, above farm Rooikrans, 15 km from Uitenhage, near the Groendal Forest Reserve, foothills of the Winterhoek mountains (-CA), 2-1973, *Olivier 615* (GRA); Otterford Forest Reserve (-CC), 31-9-1947, *Rodin 1128* (BOL, K, MO); 13-11-1986, *Stirton & Zantovska 11619* (K, MO, PRE).

20. Otholobium racemosum (Thunb.) C.H. Stirton in S. Afr. J. Bot. 52: 3 (1986).

Psoralea racemosa Thunb., Prodr. 135 (1800); Fl. Cap. 607 (1823); Poir. in Lam., Method. 696 (1804); DC., Prodr. 2: 218 (1825); Walp., Repert. 1:657 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 151 (1862); Forbes in Bothalia 3: 135 (1930). non E. Mey., Comm. 87 (1836). Holotype: "Cap. Bon. Spei.", *Thunberg* s.n. (UPS - Thunb. 17581, seen on microfiche).

P. hilaris Eckl. & Zeyh., Enum. 230 (1836); Walp., Repert. 1: 658 (1842). Lectotype: "Inter gramina montium in Langekloof (George)", *Ecklon* s.n. (S, lecto; S, SAM, TCD, iso)

Slender ascending suffrutex up to 30 cm high, coppicing after fire; plants become wiry and stiffly shrubby after a number of years, up to 80 cm high, and bear a different foliage of rigid narrowly oblanceolate leaves. *Stems* few to many, flexuous, branches incurved, pubescent, glandular, leafy. *Leaves* digitately trifoliolate, shortly petiolate. *Leaflets* unequal; terminal leaflet 25 -- 30 mm long, 5,0 -- 7,5 mm wide, coriaceous, oblanceolate, glabrous, flat; laterals smaller, symmetrical; base cuneate, apex obtuse, mucro arching, 0,6 mm long; young leaves sparingly hirsute on midrib, glabrescent; glands variously sized, more numerous on the upper surface, crateriform, petiole 2 -- 4 mm long, petiolule <0,5 mm long. *Stipules* 3 -- 4 mm long, subulate, caducous. *Inflorescences* spicate, terminal, subsessile, interrupted, rhachis often flexuous, laxly many-flowered, comprised of 10 -- 25 triplets of sessile flowers, each triplet subtended by a 3 mm long, persistent, naviculate, narrowly-lanceolate glandular bract. *Flowers* pale mauve to deep purple, 10 mm long, pedicel <2 mm long. *Calyx* about half the length of the corolla; lobes subequal, carinal lobe the longest, 6 mm long, others 5 mm long, all same width, vexillar teeth fused slightly above the tube; teeth lanceolate, hispidulous, nigro-punctate. *Standard* 9 -- 10 mm long, 7,0 -- 7,5 mm wide, claw shorter, 1,0 -- 1,5 mm long,

Otholobium racemosum (Thunb.) C.H. Stirton

Fig. 9.45 *Otholobium racemosum*. 1, Flowering stem, $x^2/_3$; 2, Digitately trifoliolate leaflet, x1,5; 3, Flower, x4; 4, Standard, x3; 5, Wing petal, x4; 6, Keel petal, x4; 7, Pistil, x4; 8, Calyx opened out, inner face, x4; 9, Flower bract, x15; 10, Triplet bract, x15 (*Fourcade 6266*).

broadly ovate, auriculate, apex truncate. *Wing petals* 9 -- 10 mm long, 3 mm wide, claw 2,5 -- 3,0 mm wide, auriculate, sculpturing upper basal and upper left central, comprised of 20 -- 30 transcostal variously sized lamellae in 2 -- 3 irregular rows. *Keel petals* 6,0 -- 6,5 mm long, 2,5 -- 3,0 mm wide, claw 2,5 -- 3,0 mm long. *Androecium* 6 -- 7 mm long, vexillar stamen free, lightly adherent to the middle of the adaxially split sheath. *Pistil* 6 mm long; ovary 1,50 -- 1,75 mm long, densely glandular, sometimes on base of style, stipitate; entasis broadest at point of flexure, height of curvature 2 mm, stigma wider than style below, penicillate. *Fruit* and seeds unknown. Fig. 9.45.

Otholobium racemosum is a scarce pyrophyte of mountain fynbos of the central southern Cape mountains (Fig. 9.46). It is usually encountered in small localized colonies. It occurs at an alititude of 900 -- 1000 m. Flowering takes place between November and January with a peak in November.

O. racemosum has been thoroughly confused in the past with *O. hamatum* but it is readily separated from that species by its dense racemes, digitately trifoliolate leaves, pale mauve to deep purple flowers and geographical distribution.

Specimens examined

-3322(Oudtshoorn): Elandsvlakte, western Kammanassie Mountains (--DB), 11-1-1977, *Bond 855* (PRE, SAAS); Kammanassie (--DB), 10-1-1977, *Zeeman 18* (SAAS); Buffelsberg (--DB), 16-12-1983, *Vlok 767* (SAAS).

-3323 (Willowmore): Prince Alfreds Pass (--CA), 11-1927, *Fourcade 3492* (BOL, FOUR, STE); 2-2-1949, *Van Zinderen Bakker 52* (NBG); 25-11-1874, *Fourcade 6266 (STE);* Misgund, Van Niekerks Kop (--CD), 11-1972, *Skinner 3* (GRA).

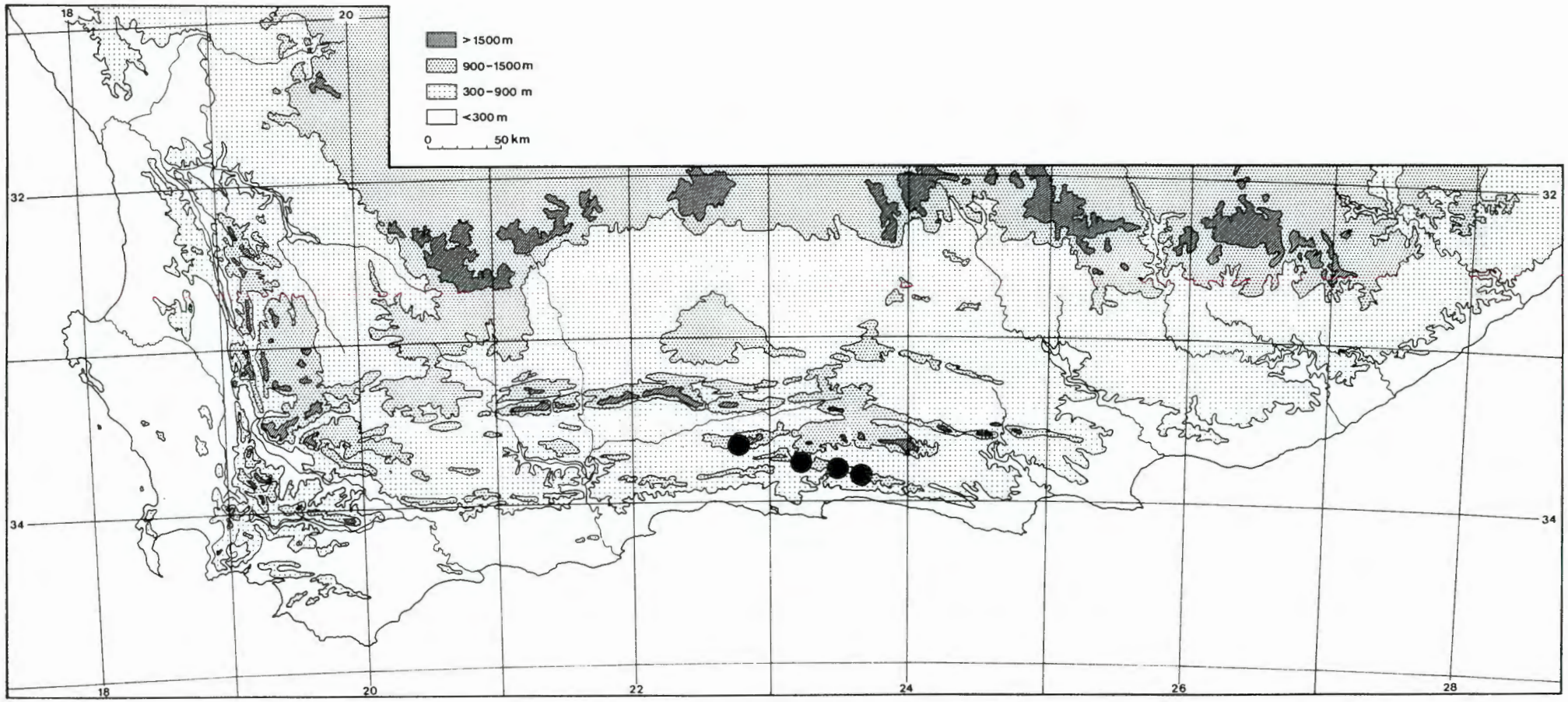


Fig. 9.46 Known distribution of *Otholobium racemosum* (Thunb.) C.H. Stirton in southern Africa.

Without precise locality: *Thunberg* s.n. (UPS, Thunberg herbarium 17581); near Bothasberg, *Ecklon & Zeyher* s.n. (MEL 1542086); Langekloof, *Ecklon & Zeyher* s.n. (S, TCD).

21. Otholobium flexuosum C.H. Stirton, *sp.nov., O. argentei affinis sed foliis atroviridibus foliolis glabris supreme nitidis inferne sparsim sericeis, axis inflorescentiae flexuosa et floribus robuste pedicellatis differt.*

Typus: 28 km from Garies to Khamieskroon (--BD), 5-11-1986, *Stirton & Zantovska 11442* (NBG, holo; BOL, C, G, K, L, M, MO, PRE, iso).

Frutex densus multiramosus usque 2,5 m altus. Rami atro-brunnei, sparse lenticellate, laeves, supperficie hebeti, juventute pubescente. Folia digitatim trifoliolata peliolata. Foliola 11 -- 14 mm longa, 7 -- 10 mm lata, late obovata, recurvato-mucronata, < 0,5 mm longa, apice emarginata, basi cuneata, conduplicata, margine laevia, inferne sparsim sericea, supreme glabra nitida; peliolus 2,0 -- 2,5 mm longus, post casum foliolosum persistens; petioluli 1,5 mm longi sericei. Stipulae 1 mm longae, setaceae, caducae, rectae. Inflorescentiae in ramulis brevibus usque 30 mm longis terminales, laxae, 5 - 20 mm longae, floribus pedicellatis in gregibus 5 -- 6 trifloris aggregatis; grege omni a bractea mox caduca brevi, 1 mm longa oblonga glandulosa subtenta. Flores 8 -- 10 mm longi, ebracteati, virido albidi; pedicellus 2 -- 3 mm longus, fructa usque 4 mm elongatus. Dentes calyces tubus aequantes, inaequales, ventricosi; lobus carinalis quam alii latior et pasum longior, 5 mm longus, 1,5 mm latus; lobi vexillares quam alii multo magis connati; sparse sericei, pilis fuscis; dentes quam tubum magis glandulosi, glandulis magnitudine diversis. Vexillum 8,0 -- 8,3 mm longum, 5,5 mm latum, album, obovatum, latis reflexis. Alae 13 -- 9 -- 10 mm longae, 2,5 mm latae, quam carina multo longiores. Petala carinae 5,5 mm longa, 2,5 mm lata. Androecium 7 mm longum, vagina adaxialiter fissa, stamen decimum in dimidio basali lateris sinistri connatus. Pistillum 6,5 mm longum; ovarium 2 mm longum dense sericeum; pars curvata 1,5 mm alta; stylus gracilis pro parte maxima ante partem flexuosam incrassata; stigma penicillatum. Fructus 6 mm longus, 3 mm latus, sericeus. Semina 4,0 mm longa, 2,5 mm lata, pallide brunnea.

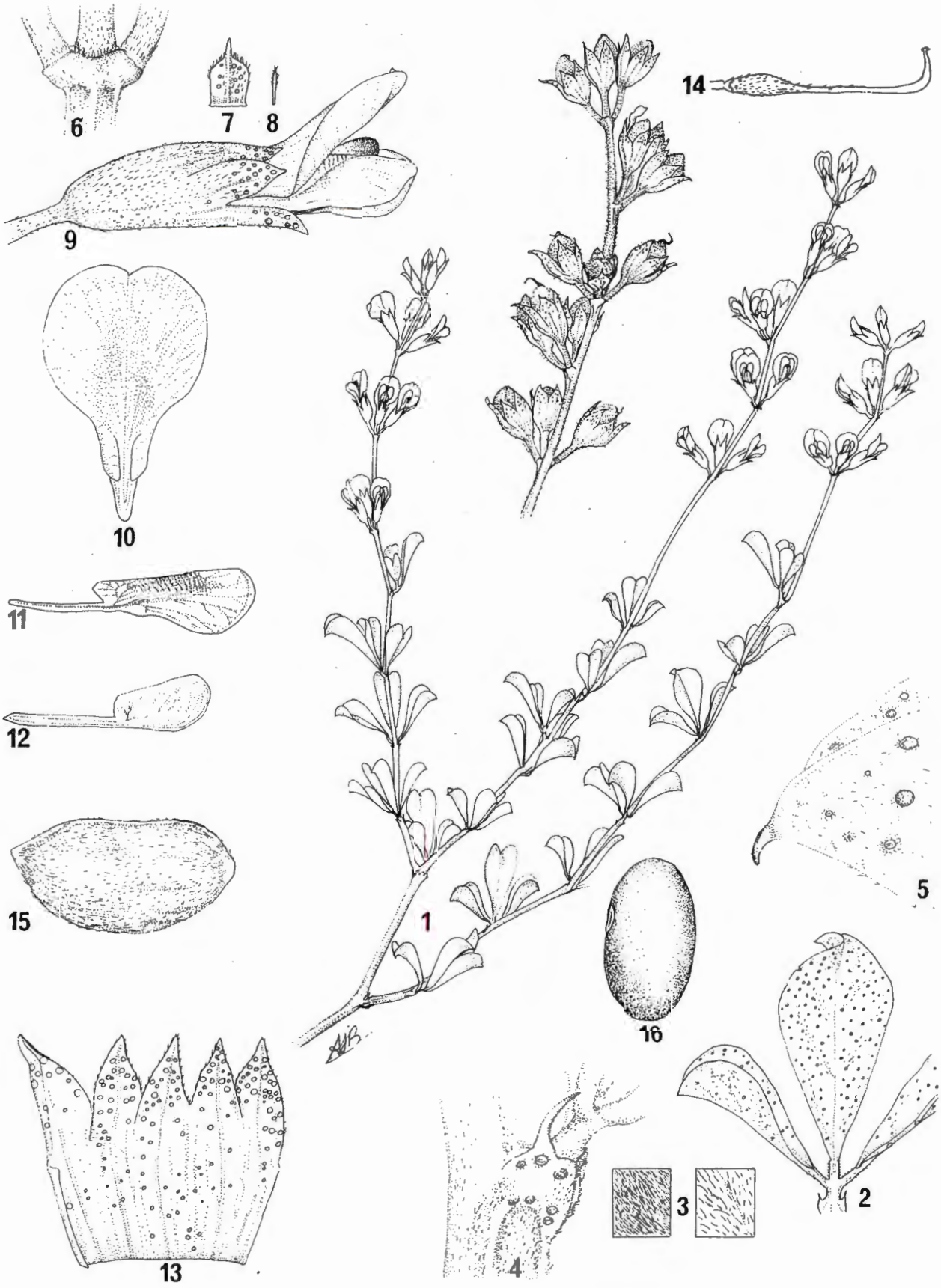


Fig. 9.47 *Otholobium flexuosum*. 1, Flowering branch, x1; 2, Digitately trifoliolate leaflet, terminal showing upper surface, laterals in side view, x2,5; 3, Vestiture on lower surface of leaflets, LHS young leaflets, RHS older leaflets, x30; 4, Stipule, side view, x10; 5, Apex of terminal leaflet, x10; 6, Apex of peduncle showing position of pedicels, x10; 7, Triplet bract, x6; 8, Flower bract, x6; 9, Side view of flower at anthesis, x8; 10, Standard, inner face, x5; 11, Wing petal, x5; 12, Keel petal, x5; 13, Calyx opened out, inner face, x5; 14, Pistil, x6; 15, Fruit, x7; 16, seed, x7 (*Stirton & Zantovska 11442*).

Dense, much branched, rounded shrub up to 2,5 m tall. **Branches** brownish-black, sparsely lenticelled, smooth, surface dull; pubescent when younger. **Leaves** digitately trifoliolate, petiolate. **Leaflets** 11 -- 14 mm long, 7 -- 10 mm wide, broadly obovate; recurved mucronate, < 0,5 mm long; apex emarginate, base cuneate, partly conduplicate, margin smooth, sparsely sericeous below, glabrous and nitid above; glands more dense on upper surface, petiole 2,0 -- 2,5 mm long, persistent once leaflets have dropped; petiolules 1,5 mm long, sericeous. **Stipules** 1 mm long, setaceous, caducous, straight. **Inflorescences** terminal on short shoots up to 30 cm long, lax, 5 -- 20 mm long, comprised of 5 -- 6 triplets of pedicellate flowers; each triplet subtended by a rapidly caducous, short, 1 mm long, oblong, glandular bract. **Flowers** 8 -- 10 mm long, bract minute, lenear, greenish-white; pedicel 2 -- 3 mm long, increasing to 4 mm in fruit. **Calyx teeth** equal in length to the tube; unequal; carinal lobe broader and slightly longer than other lobes, 5 mm long, 1,5 mm wide; vexillar lobes fused much higher up than the rest; sparsely sericeous, hairs dark; teeth more glandular than on the tube, glands variously sized. **Standard** 8,0 -- 8,3 mm long, 5,5 mm wide, claw 1,5 mm long, white; obovate, sides reflexed, apex emarginate, scarcely auriculate. **Wing petals** 6,5 -- 7,0 mm long, 2,5 mm wide, claw 3 mm long; much longer than keel petals, auricle prominent; sculpturing upper central comprising from 15 -- 19 rows of indistinct transcostal lamellae. **Keel petals** 5,5 mm long 2,5 mm wide, claw 5 mm long. **Androecium** 7 mm long, sheath split adaxially, vexillar stamen fused for lower half on left side of split; fenestrate anthers equal. **Pistil** 6,5 mm long; ovary 2 mm long, densely sericeous; height of curvature 1,5 mm long, style thin, mostly thickened before curvature; stigma penicillate. **Fruits** 6 mm long, 3 mm wide, sericeous, papery, glandular; style persistent; reticulate. **Seeds** 4 mm long, 2,5 mm wide, pale brown, hilum central. Fig. 9.47.

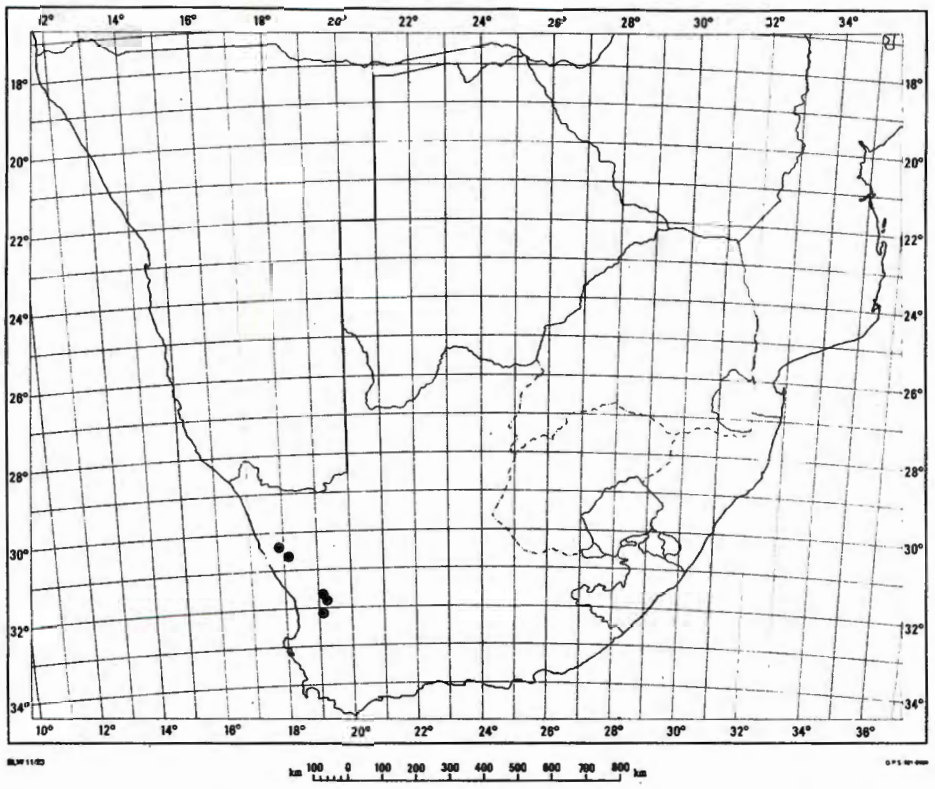


Fig. 9.48 Known distribution of *Otholobium flexuosum* C.H. Stirton in southern Africa.

This little known species grows along the margins of arid fynbos, karoid broken-veld and in renosterveld (Fig. 9.48) at altitudes between 650 -- 850 m. Flowering takes place in September and October.

O. flexuosum is easily identified in the reproductive phase. It has lax, zig-zag like inflorescences bearing triplets of pedicellate flowers. From *O. arborescens* C.H. Stirton it is distinguished by dense branching, its lax zig-zag inflorescences, pedicellate greenish white flowers and setaceous caducous stipules. *O. arborescens* has a virgate habit, straight compact many-flowered inflorescences, white or cream flowers, and persistent orange glanded stipules. *O. striatum* can be distinguished from it by its larger leaves, densely silky stems and yellow flowers. *O. incanum* and *O. argenteum* are both low spreading shrublets with densely silvery leaves.

Specimens examined

-3017 (Hondeklipbaai): 28 km from Garies to Khamieskroon (--BD), 4-12-1981, *Stirton 10140* (K, PRE); 5-11-1986, *Stirton & Zantovska 11442* (K, NBG).

-3018 (Kamiesberg): Khakamas, between Garies and Bitterfontein (--CA), 5-12-1981, *Stirton 10164* (K, MO, PRE).

-3119 (Calvinia): Lokenburg, 21 miles south of Niewoudtville (--CA), 10-1-1953, *Acocks 17340* (K, PRE); (-CA), 10-10-1953, *Story 4295* (PRE).

-3219 (Wuppertal): Mertenhof, Biedouw Valley (--AA), 12-11-1974, *Van Breda 4325* (K, PRE); Uitkyk Pass, Biedouw Valley (--AA), 7-11-1986, *Stirton & Zantovska 11502* (NBG, K).

22. Otholobium fruticans (L.) C. H. Stirton in S. Afr. J. Bot. 52: 3 (1986).

Trifolium africanum fruticans flore purpurasente. Comm., Horti med. amstelod. 2: 211, t.106 (1701) and Atlas 5, t.33; Hill, Eden. 103, t. 9.6 (1757). Wijnands (1983) reports that in 1697 Commelin received from the Cape some seeds of this species, sent as *Lagopus frutescens* but presumably meant to be *Sutherlandia frutescens*.

Trifolium africanum lagopodiodes, frutescens; foliis uva ursinia, punctatis. Rai., Suppl. 464 (1704).

Cytisi facie frutex, Capitis bonae-spei, foliis perforatis. Petiv. Gaz. 23 (1702).

Trifolium spicis subvillosis; lacinia calicum infima maxima, foliis fere sessilibus. L., Hort. Cliff. 373 (1737); Roy. Lugd. Batav. 378 (1740); Fabricius, Enum. Ed. 2: 305 (1763).

Trifolium fruticans L., Sp. Pl. 770 (1753); Burm.f., Prodr. Fl. Cap. 22 (1768); L., Mant. Pl. altera 452 (1771). *Psoralea bracteata* Berg., Descr. pl. Cat. 224 (1767), nom. illeg. The name is illegitimate since *Trifolium fruticans* L. was given as a synonym and is automatically rejected as being superfluous. Thunb. 136 (1800); Thunb., Fl. Cap. 608 (1823); L., Mant. 264 (1767); L., Mant. Pl. altera 264 (1771); Curtis, Bot. Mag. 13; 446 (1799); Poir. in Lam. Encycl. 5: 687 (1804); Eckl. & Zeyh., Enum. 229 (1836); E. Mey., Comm. 86 (1836); Richter, Codex 739 (1840); Walpers, Repert. 1: 657 (1842); DC., Prodr. 2: 218 (1825); Harv. in Harv. & Sond., Fl. Cap. 2: 154 (1862); Forbes, Bothalia 3: 126 (1930). Lectotype: provenance and collector unknown (BM, Hort. Cliff. 373.5).

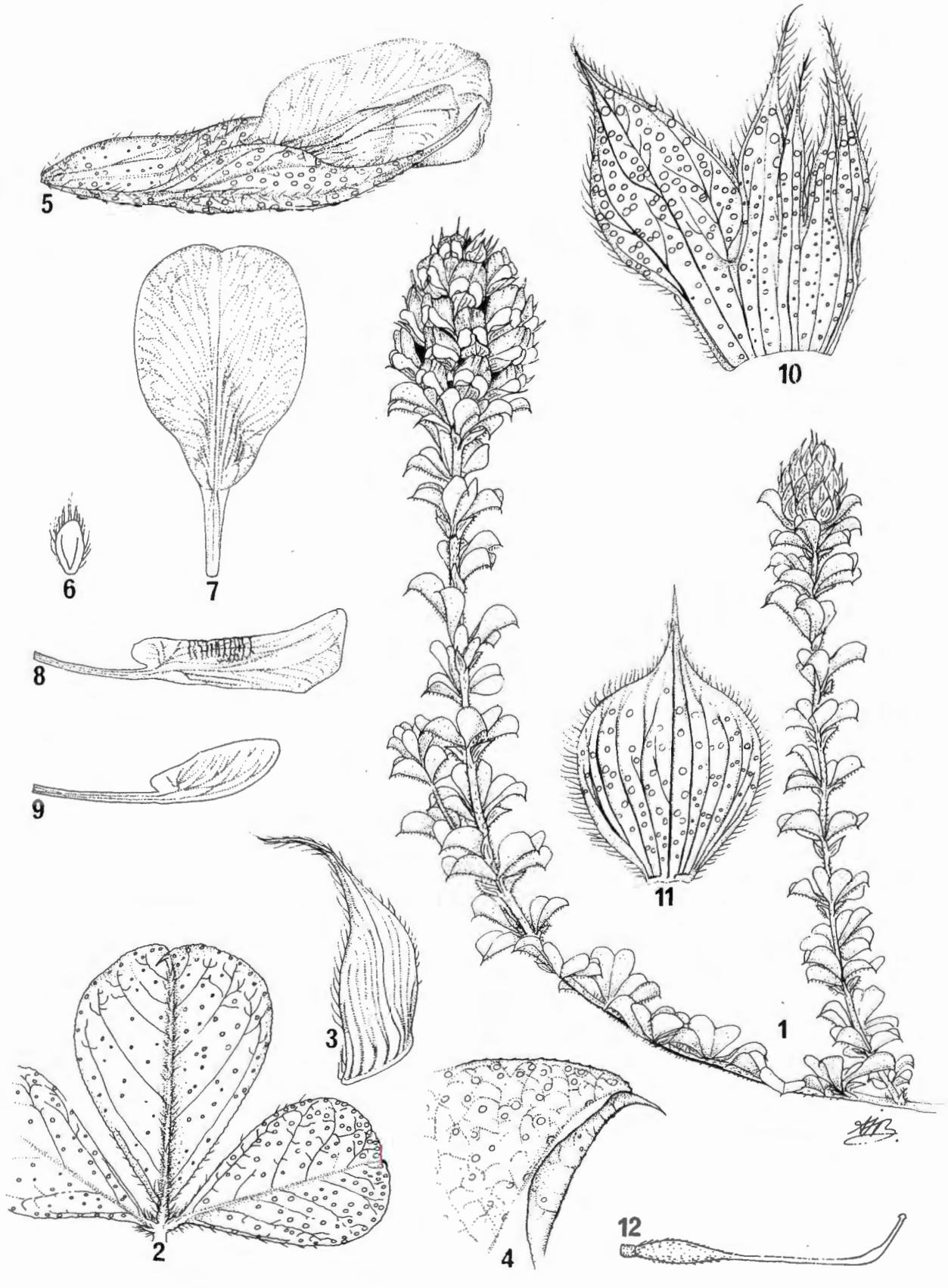


Fig. 9.49 *Otholobium fruticans*. 1, Flowering shoot, x1; 2, Digitately trifoliolate leaflet, terminal showing lower surface, laterals upper surface, x2; 3, Stipule, x6; 4, Apex of terminal leaflet; 5, Side view of flower at anthesis, x6; 6, Flower bract, x6; 7, Standard, x5; 8, Wing petal, x5; 9, Keel petal, x5; 10, Calyx opened out, inner face, x6; 11, Triplet bract, x6; 12, Pistil, x7 (1, *Worsdell* s.n.; 2-12, *Stirton 9963*).

Ononis trifoliolata L., Syst. Nat. 12,2: 479 (1767).

P. cuneifolia Du Mont de Courset, Le Bot. cult. 6: 101, ed.2 (1812). Type: Herbarium and types unknown (fide Stafleu & Cowan, Taxon. Lit. 1: 696, 1976).

P. aculeata Thunb., Fl. Cap. 607 (1823) non L. (1753).

P. bracteata L. var. *curtisiana* E. Mey. Comm. 86 (1836). Type: I have not been able to trace a specimen of the variety.

P. bracteata L. sensu Loddiges, Bot. Cab. 16: t. 1559.

P. fruticans (L.) Druce, Rep. Bot. Exch. Bri. Isles 1913: 422 (1914); Kidd, Wildlflow. Cape Penins. t.70.7 (1950); Adamson & Salter, Fl. Cape Penins. 487 (1950).

Lotodes fruticans (L.) O.K., Gen. Pl. 3,2: 65 (1891).

Decumbent to prostrate subshrub, up to 0,4 m tall. **Stems** 3 -- 7, with many erect branches; pubescent. **Leaves** digitately trifoliolate, petiolate. **Leaflets** (8) 10 --15 (17) mm long, 6 -- 10 mm wide, broadly obovate; rigid, spreading, mucronate, mucro slender, arching up to 1,5 mm long; apex emarginate, base cuneate, half-conduplicate and clasping the stem when young but flattening and spreading with age, pellucid-dotted when fresh, margin irregularly crenate, younger leaves glabrous except for sericeous midrib and margins; petiole 2 -- 3 mm long; petiolules 1 mm long, sericeous. **Stipules** 6 -- 8 mm

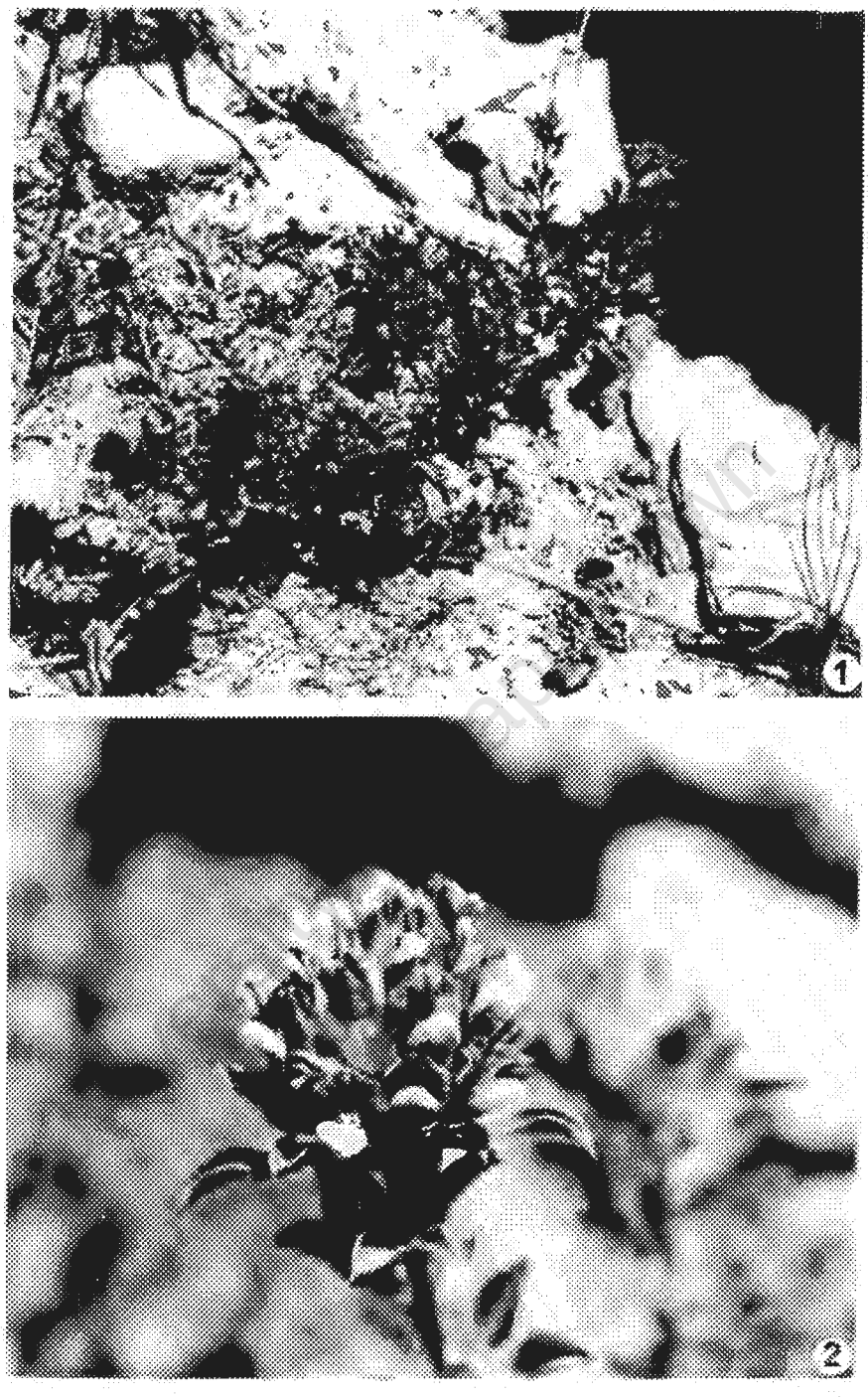


Fig. 9.50 *Otholobium fruticans*. 1, Habit; 2, Inflorescence, notice overlapping wing petals (*Stirton 9963*).

long, 2 mm wide, longer than petioles, lanceolate, arching outwards, persistent, margins ciliate, glands not evident. **Inflorescence** solitary, in terminal axil of each short shoot, compact, 20 -- 30 mm long, broadly ovate, comprised of 6 -- 7 triplets of sessile flowers, uppermost and lowermost subtending bracts contain aborted flowers, each triplet subtended by a 10 -- 11 mm long, 5 -- 7 mm wide, broadly obovate, attenuately tipped, gland-dotted bract with sericeous margins; peduncle shorter than the subtending stipules. **Flowers** 13 -- 14 mm long, reddish violet to deep lilac, bract minute. **Calyx teeth** longer than calyx tube; unequal, narrowly to broadly ventricose; carinal tooth twice as broad as other teeth; 10 -- 11 mm long, 5 -- 5,5 mm wide; vexillar lobes fused higher up than the rest; sparsely sericeous, hairs white; glandular on teeth; yellowish green with teeth flushed purple; accrescent. **Standard** 10 -- 13 mm long, 5,0 -- 8,0 mm wide, reddish violet to bluish violet with a nectar guide of deep lilac surrounded by a white halo flecked with purple, obovate, sides reflexed; apex hooded, distinctly auriculate, claw prominent, half the length of the blade; glabrous. **Wing petals** 11 mm long, 2,0 --2,5 mm wide, claw 4 mm long, much longer than keel petals; exposed areas deep mauve; sculpturing upper central and upper basal comprising 15 -- 20 transcostal lammellae, rows indistinct. **Keel petals** 7 -- 8 mm long, 2 mm wide, claw 5 mm long, longer than blade. **Androecium** 8 --9 mm long, vexillar stamen fused for basal third of its length, sheath fused near base, anthers equal. **Pistil** 6 -- 7 mm long; ovary 1,5 -- 2,0 mm long, glabrous to sparsely hairy with scattered glands; height of curvature 1,5 -- 2,0 mm long, style thin but thickened before curvature, stigma papillose. **Fruit** and seed unknown. Fig. 9.50.

Otholobium fruticans is endemic to the Cape Peninsula (Fig. 9.51). It occurs at altitudes from 180 -- 600 m. It favours steep slopes with rocky outcrops. Flowering takes place from late September to early January with a peak in October.

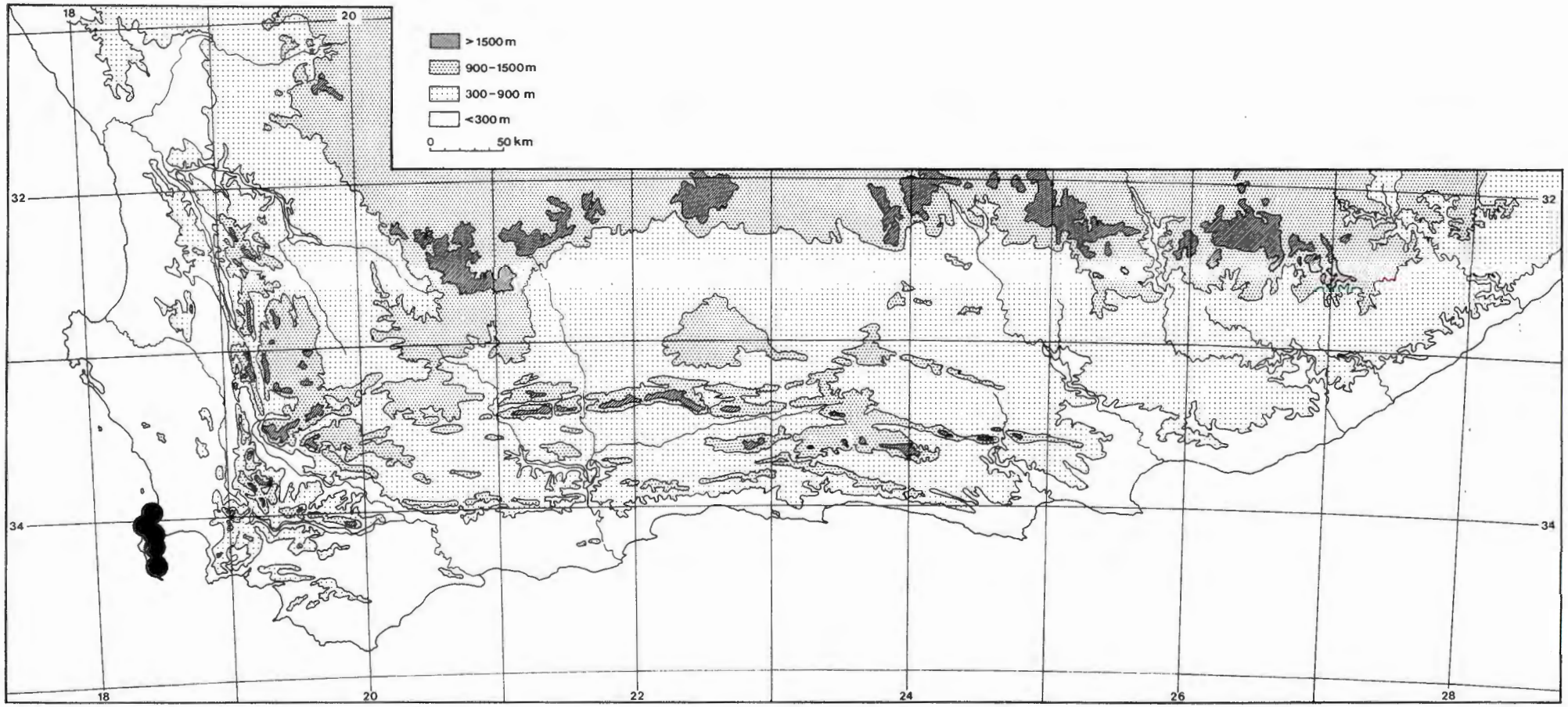


Fig. 9.51 Known distribution of *Otholobium fruticans* (L.) C.H. Stirton in southern Africa.

O. fruticans has been confused with *O. bracteolatum* by most authors and collectors. They may however be separated as follows:

Small weak decumbent to prostrate subshrub < 0,5m high; margin of leaflets irregularly crenate, sericeous; stipules 6 -- 8 mm long; inflorescence with 18 -- 21 flowers, each triplet of flowers subtended by a 5 -- 7 mm wide bract; flowers 13 -- 14 mm long; calyx teeth longer than tube, distinctly overlapping; ovary with few scattered hairs and stalked glands at the distal end; style glabrous, entasis thickest before flexure, tapering to stigma .....*fruticans*

Robust straggling subshrub to erect compact shrub > 0,5 m tall; margin of leaflets smooth, glabrous; stipules up to 5 mm long; inflorescence with 30 -- 45 flowers, each triplet subtended by a 2,5 mm wide bract; flowers 8 -- mm long; calyx teeth more or less equal to the tube; ovary sericeous; style sericeous until point of flexure, entasis thickened after flexure ..... *bracteolatum*

Specimens examined

-3318 (Cape Town): Table Mountain (--CD), 10-1873, *Bolus 1085* (BOL); 1-1950, *Sheasby 25* (NU); *Harvey* s.n. (MEL 1542123, TCD); 10-1897, *Thode 6075* (STE); 5-12-1810, *Burchell 77* (K); near Cape Town (--CD), *Burchell 8490* (K); *Ecklon & Zeyher* s.n. (PRE); *Ecklon 664* (E, K, OXF, PRE, SAM, TUB); 1928, *Ryder* s.n. (K); Spring Buttress on Pipe track, Table Mountain (--CD), 11-1972, *McKinnon 338* (STE); Devils Peak (--CD), 10-1846, *Alexander Prior* s.n. (PRE); Saddleback (-CD), 11-1886, *Thode 9392* (STE); above Oranjezicht (--CD), 10-1913 *Kensit* s.n. (PRE 16214); Cape Town (--CD),

11-1921, *Rogers 27003* (PRE); 9-11-1931, *Levyns 3597* (BOL); National Botanic Gardens, Kirstenbosch (--CD), 10-1924, *Forbes 90* (PRE); 12-11-1941, *Walgate 420* (BOL); Rhodes Estate (--CD), 30-11-1980, *Stirton 8422* (K); Groote Schuur (--CD), 5-11-1956, *Esterhuysen 26477* (BOL); above Camps Bay (--CD), 26-10-1944, *Barker 3213* (NBG); between Kuils River and Green Point (--CD), *Zeyher 31* (K); Cape Town (-CD), 11-1912, *Worsdell* s.n. (K).

-3418 (Simonstown): Camps Bay (--AB), 27-12-1810, *Burchell 308* (K); 26-10-1944, *Barker 3213* (NBG); 12-1932, *Letty 236* (PRE), 18-10-1938, *Penfold 159* (NBG, PRE); 27-9-1938, *Salter 7701* (BOL); 12-12-1927, *Young 361* (PRE); Tokai (--AB), 20-8-1935, *Hubbard 46* (STE); Vlakkenberg (--AB), 28-11-1981, *Stirton 9963* (K, PRE); Muizenberg (--AB), 4-1884, *MacOwan 71* (K, W); 10-1915, *Pillans 3427* (BOL, PRE); Fish Hoek (--AB), 27-12-1895, *Wolley-Dod 713* (BOL, K); Koelbaai, rocky hillside (--AB), 27-11-1981, *Stirton 9970* (K, PRE); Chapmans Peak (--AB), 13-10-1940, *Bond 681* (NBG, PRE); 7-12-1943, *Compton 15438* (NBG); 7-12-1943, *Van Niekerk 461* (NBG, PRE); Rondebosch and Wynberg (--AB), *Ecklon & Zeyher 3550* (PRE); Wynberg (--AB), *Wolley-Dod 19* (BOL); plateau between Kalk Bay Mountain and Steenberg Peak (--AB), 10-1946, *Lewis 1812* (NBG, SAM); Bokkop, Silvermine Nature Reserve (--AB), *Stirton 1 1218* (K, PRE); Constantia Nek (--CB), 10-1909, *Dummer 731* (E); Kalk Bay Mountain (--AB), 16-10-1946, *Baker 4915* (NBG, PRE); Signal Hill (--AB), 12-1915, *Marloth 7392* (PRE); Red Hill (--AB), 4-9-1896, *Wolley-Dod 1868* (K); 22-10-1962, *Taylor 4187* (PRE, STE); 1-11-1964, *Taylor 6010* (STE); Simons Bay (--AB), *Wright* s.n. (PRE, TCD); 4-11-1913, *Peter 511*; hills above Hesterdam (--AD), 31-10-1971, *Taylor 8034,* (PRE, STE); between Smitswinkel and Cape Point (--AD), 18-10-1932, *Herre* s.n. (STE); Cape Point (--AD), 3-11-1924, *Forbes 182* (PRE); Rhodes Memorial 3318 (--CD), 1-1950, *Sheasby 25* (PRE); mountains between Kommetjie and Glencairn (--~~CD~~ AD), 1-11-1964, *Schelpe 696* (BOL).

Without precise locality:*Ecklon & Zeyher 665* (E); *Ecklon & Zeyher 1542* (PRE); Cape Peninsula, 10-1940, *Esterhuysen 23* (PRE); Cape, *Foster 1344* (K); Cape Peninsula, 4-10-1930, *Fries, Norlindh & Weimarck 1692* (K); C.B.S., *Harvey* s.n. (E, K, TCD); Lakeside, 5-2-1918, *Moss & Rogers 1633* (PRE); *Scott-Elliott* sn. (E); C.B.S., *Sieber* s.n. (K); *Verreaux* s.n. (G); C.B.S., *Wallich* s.n. (G, K); Cape Flats, *Zeyher* s.n. (?).

23. Otholobium virgatum (Burm.f.) C.H. Stirton, comb. nov.

Psoralea virgata Burm. f., Fl. Cap. 21 (1736). Holotype: *Oldenland* s.n. (G, holo).

Psoralea strigosa Burm.f., Fl. Cap. 21 (1736). Holotype: *Oldenland* s.n. (G, holo).

Psoralea decumbens Ait., Hort. Kew. 3: 80 (1789); Lodd. Bot. Cab. t. 282 (1818); DC., Prodr. 2: 217 (1825); E. May., Comm. 86 (1836); Eckl. & Zeyh., Enum. 228 (1836); Walpers in Linnaea 13; 514 (1839); Forbes in Bothalia 3: 136 (1930); Adamson & Salter, Fl. Cape Penins. 488 (1950); Kidd, Wildfl. Cape Penins. t. 70,3 (1950). Holotype: without precise locality, *Masson* s.n. (BM).

P. decumbens Ait. var. *obcordata* Eckl. & Zeyh., Enum. 228 (1836). Lectotype: "in humidis et pratensibus (altit. 1) campestrium ad flumen Zwartkopsrivier (Uitenhage)", *Ecklon & Zeyher* s.n. (K, lecto; BOL, SAM, TUB, iso).

P. decumbens Ait. var. *pubescens* Eckl. & Zeyh., Enum. 228 (1836). Lectotype: " in sabulosis (altit. III) fruticum ad montis latera Bothasberg (Albany)", *Eckl. & Zeyh.* s.n. (W, lecto; K, iso).

P. decumbens Ait. var. *subglabra* Eckl. & Zeyh., Enum. 228 (1836). Type: not seen.

P. ononoides Poir. in Lam., Method. 5: 688 (1804) non Burm. f. (1768). Holotype: " Cap de Bonne-Esperance", *Sonnerat* s.n. (P-JA).

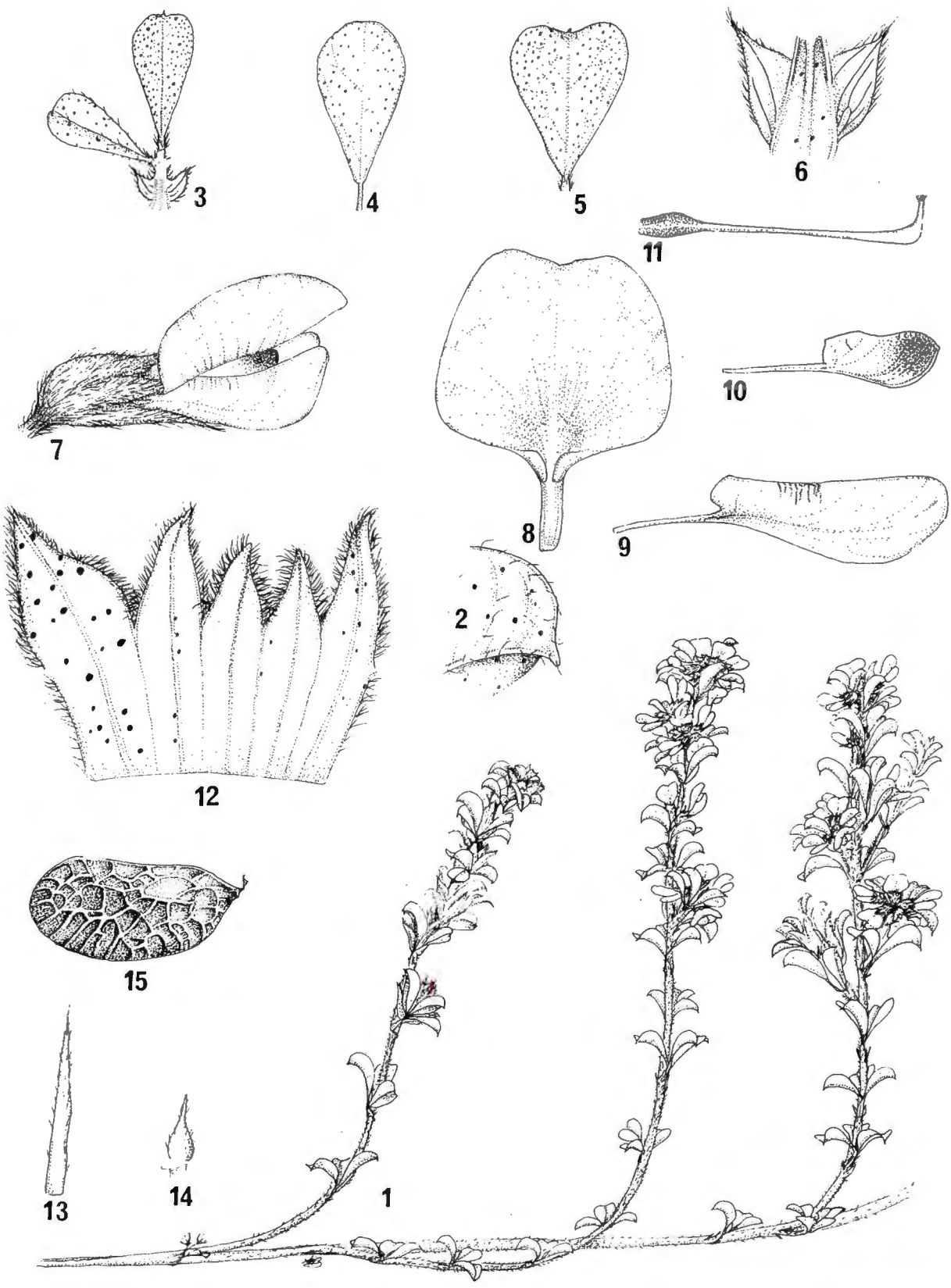


Fig. 9.52 *Otholobium virgatum*. 1, Flowering branches of portion of prostrate stem, $x^2/_3$; 2, Apex of terminal leaflet, x10; 3, Typical digitately trifoliolate leaflets, terminal showing upper surface, lateral showing lower surface, x2,5; 4, Leaflet from Onrust area, x3; 5, Leaflet from Loerie region, x3; 6, Stipules , x3,5; 7, Flower, x5; 8, Standard, x5; 9, Wing petal, x5; 10, Keel petal, x5; 11, Pistil, x9; 12, Calyx opened out, inner face; 13, Triplet bract, x6; 14, Flower bract, x5; 15, Fruit, x8 (1-3, 6-14, *Stirton 9945*; 4, *Gillett 4398*; 5, *Long 1354*).

Ononis decumbens Sieb. nom. nud. This name appears frequently on early herbarium sheets.

P. hirta Thunb., Fl. Cap. 609 (1823) pro parte non L. (1753). The LHS specimen of the type sheet (17573) in UPS - Thunb. is *O. candicans* (Eckl. & Zeyh.) C. H. Stirton whereas the RHS specimen is *O. decumbens.*

Otholobium decumbens (Ait.) C. H. Stirton in S. Afr. J. Bot. 52: 2 (1986).

Decumbent, matted shrub. **Stems** slender, trailing, woody, sparsely to densely leafy, striate; young shoots densely clothed with white or reddish pubescence, often erect. **Leaves** digitately trifoliolate, stipulate, petiolate. **Leaflets** subequal, terminal leaflet 6 -- 8 mm long, 4 -- 7 mm wide, laterals smaller, obovate to obcordate, symmetrical, recurved-mucronate, mucro short, apex truncate, rounded to deeply emarginate, base cuneate; pubescence copious or sparse, older leaves glabrous, nigro-punctate on both surfaces (in dry state); petiole 2 -- 3 mm long, petiolule <1 mm long. **Stipules** 4 -- 5 mm long, subulate. **Inflorescences** axillary, crowded often towards the ends of very short seasonal shoots sometimes forming an imperfect capitulum, comprised of a single triplet of pedicellate flowers, each triplet subtended by a persistent, short 1,5 -- 2,0 mm long, ciliate, 1 -- 3 oblong or linear bract. **Flowers** 8 -- 9 mm long, pale-purplish blue, pedicel 2,0 -- 2,5 mm long. **Calyx** about half the length of the flower, carinal lobe longest, 5 -- 6 mm long, 1,5 mm wide, tooth broadly triangular; other teeth shorter, vexillar pair shortest, not fused above the 2,5 -- 3,0 mm long tube, all lanceolate acute, villous or sparsely hirsute on veins, teeth ciliate, shortly pilose on inner surface; glands small, reddish-brown, present on tube and lobes, especially on carinal lobe. **Standard** 7,5 -- 8,0 mm long, 4,5 -- 5,0 mm wide, claw 2 -- 3 mm long, broadly ovate to elliptic, apex emarginate to obtuse, auriculate. **Wing petals** 7 -- 8 mm long, 2 mm wide, claw 3 mm long, auriculate, longer than the keel; sculpturing present, upper central, comprised of 10 -- 12 ir-

regular lamellae. **Keel petals** 5,0 -- 5,5 mm long, 1,3 -- 1,5 mm wide, claw 3 mm long. **Androecium** 5 mm long, vexillar stamen fused to split adaxial sheath in lower half. **Pistil** 4,5 -- 5,5 mm long, ovary <1 mm long, glandular, entasis best developed before curvature, height of curvature 1 mm. **Stigma** penicillate. **Fruits** 3,5 mm long, 2 mm wide, reticulate. Fig. 9.52.

Otholobium virgatum is a variable, widespread and common species occupying diverse habitats, being particularly successsful in disturbed areas. Fig. 9.53. It occurs from sea-level to 350 m. Flowering takes place from August to November with a marked peak in November.

This species requires further detailed study in the field. A number of distinct localized forms occur.

Specimens examined

-3217 (Vredenburg): Witteklip Rocks (--DD), 18-9-1980, *Goldblatt 5847* (PRE).

-3218 (Clanwilliam): 4 miles N of Porterville (--DD), 16-9-1953, *Lewis* s.n. (SAM 65958, PRE).

-3225 (Somerset East): Cradock Common (--BA), 9-10-1974, *Bayliss 6801* (K).

-3227 (Stutterheim): Dohne Research Station (--CB), 1898, *Sim 19456* (PRE).

-3318 (Cape Town): Hopefield (--AB), 14-9-1951, *Parker 4639* (K, PRE); Witzenberg Mountains (--AC), 16-9-1980, *Schonken 299* (PRE, STE); Klipberg (--AD), *Drege* s.n. (E, G, K, P, PRE, TUB); Porterville (--BB), 25-9-1966, *Levyns 11062* (BOL); Milnerton (--

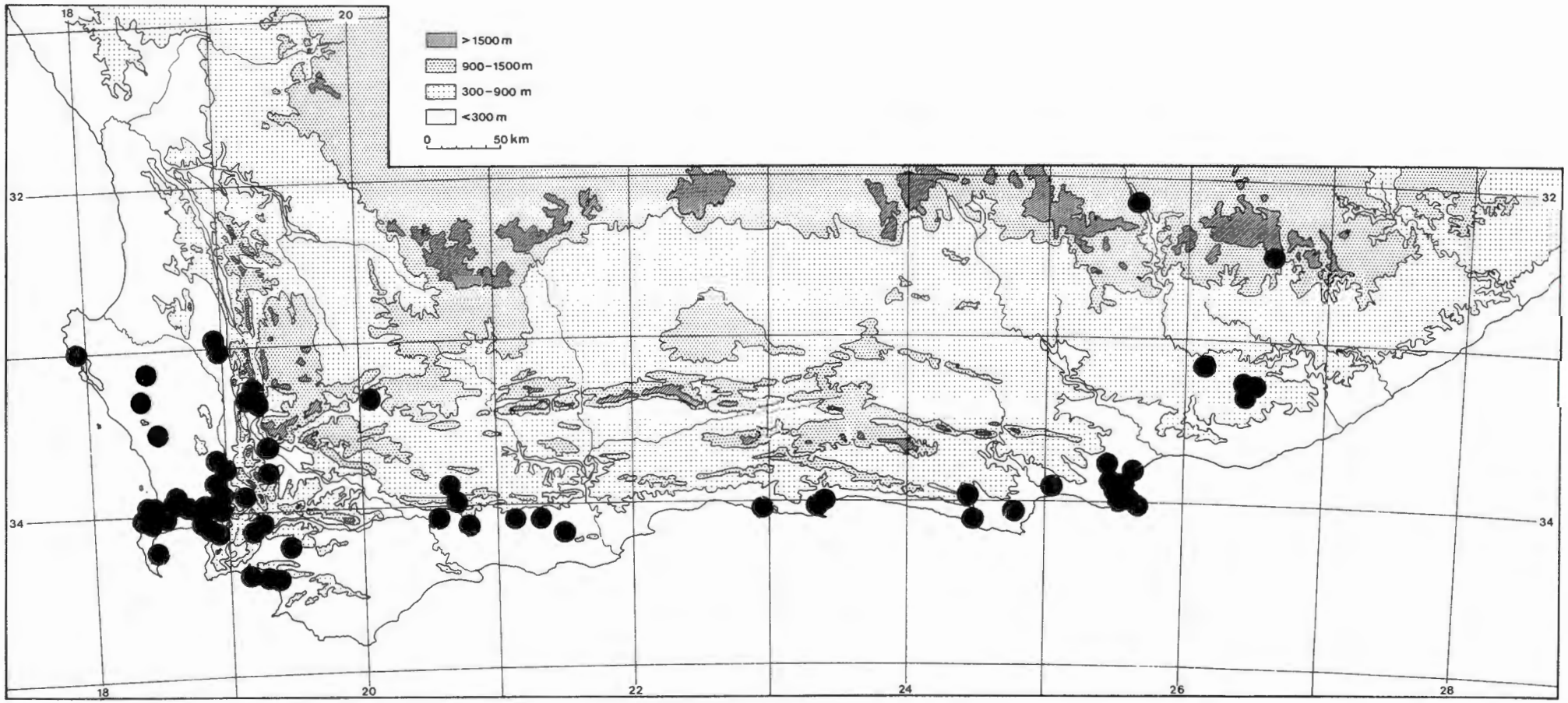


Fig. 9.53 Known distribution of *Otholobium virgatum* (Burm.f) C.H. Stirton in southern Africa.

(--CB), 12-10-1940, *Compton 9835* (NBG); 28-9-1953, *Compton 24376* (NBG, STE); Wellington (--CB), 9-1902, *Knobel* s.n. (PRE 22925); Cape Town (--CD), 1847, *Alexander Prior* s.n. (K); 7-1881, *Tyson 2446* (E); *Harvey 154* (TCD); 16-10-1942, *Compton 13907* (NBG); 31-10-1931, *Levyns 3647* (BOL); 11-1921, *Rogers 24272* (PRE); Sea Point (--CD), 21-8-1938, *Salter 7680* (BOL); Table Mountain (--CD), 10-1873, *Bolus 2770, 2771* (BOL, K, NBG, PRE); 24-1-1811, *Burchell 588* (K); *Ecklon* s.n. (K, PRE); *Ecklon & Zeyher 1538* (GRA, L, MO, SAM); *Drge* s.n. (E, G, K, TCD, W); 1820, *Kuhl & Van Hasselt* s.n. (L); 9-1882, *Macowan 73* (G, K, NBG, W); *Moss 2610* (PRE); Lions Head (--CD), 22-12-1966, *Grobbelaar 378* (PRE, PRU); Signal Hill (--CD), 8-1907, *Dummer 402* (E); 10-1908, *Dummer 706* (E); Devils Peak (--CD), *Zeyher* s.n. (SAM 3544); between Cape Town and Newlands (--CD), 3-1-1811, *Burchell 940* (K); *Burchell 485* (K, W); Kenilworth Race Course (--CD), 29-10-1975, *Esterhuysen 34052* (BOL); 3-11-1913, *Peter 510* (K); Rosebank (--CD), 10-1918, *Pillans 3474* (PRE), Camps Bay (--CD), 10-1949, *Stokoe* s.n. (SAM 61587); 26-8-1896, *Wolley-Dod 1769* (K); Agter Paarl Road (--DB), 24-9-1952, *Esterhuysen 20424* (BOL, PRE); Wellington (--DB), 10-1881, *Thompson 54* (PRE); Malmesbury (--DC), 3-1907, *Kassner 1242* (E); Tygerberg (--DC, 11-1838, *Krauss* s.n. (G, TUB); Langverwacht, Kuilsrivier (--DC), 21-10-1971, *Oliver 3689* (PRE, STE); 17-10-1973, *Oliver 4755* (PRE, STE); Koelenhof (--DD), 6-11-1957, *Morkel* s.n. (PRE, STE); Ida Valley Dam Catchment (--DD), 7-11-1976, *Taylor 9531* (K, PRE, STE); Stellenbosch (--DD), 29-10-1948, *Liebenberg 4216* (STE); Uitkyk (--DD), 21-10-1928, *Gillett 1720* (STE); between Stellenbosch and Blaauklip (--DD), 22-10-1928, *Gillett 1740* (STE); Langrivier (--DD), 10-1967, *Kerfoot 6072* (PRE, STE); Jonkershoek (--DD), 28-10-1976, *Kruger 213* (STE); 14-12-1966, *Grobbelaar 315* (PRE).

-3319 (Worcester): Steendaal (--AC), *Zeyher* s.n. (SAM 15408); *Harvey 784, 814* (E, K, TCD); Tulbagh (--AC), 11-1919, *Rogers 17436* (K); 29-9-1945, *Leighton 1314* (BOL); *Pappe* s.n. (K); 6 km W of Tulbagh (--AC), 7-10-1981, *Mauve & Hugo 50* (PRE); 12 km from Worcester on Ceres road (--CB), 16-10-1948, *Story 3591* (K); Groenrivier (--CB),

27-10-1975, *Walters 1430* (NBG); foothills of Du Toits Peak (--CC), 28-10-1950, *Esterhuysen 17626* (BOL); Fransch Hoek (--CC), 10-1913, *Phillips 1090* (PRE, SAM).

-3320 (Montagu): Matjiesfontein (--BA), 11-1928, *Fourcade 4164* (BOL, STE); Barrydale (--DC), 10-1897, *Galpin 3963* (GRA, PRE); 6 miles from Barrydale into Tradouw Pass (--DC), 18-9-1968, *Marsh 969* (K, PRE, STE).

-3324 (Steytlerville): Assegaisbosch Nature Reserve (--CD), 10-1-1983, *Grobbelaar 2726* (PRE).

-3325 (Port Elizabeth): Elandsberg,Tafelberg (--CA), 30-9-1984, *Stirton 10874* (K); Loerie turn-off (--CC), 2-10-1935, *Long 1354* (K, PRE); near Bethelsdorp (--CD), *Zeyher* s.n. (SAM); Uitenhage (--CD), *Zeyher* s.n. (BOL, MEL, TCD); Aloes (--DC) 10-1912, *Drege 3107* (GRA, PRE); in moist meadow-like spots near the Zwartkop River, (--DC), *Zeyher* s.n. (BOL, K, SAM, TUB); Port Elizabeth (--DC), 11-1894, *Laidley 210* (G); Redhouse (--DC), 9-1908, *Paterson 206* (GRA); Humewood, near Port Elizabeth (--DC), 10-1915, *Paterson 2613* (BOL, PRE, STE); Walmer (--DC), 11-1907, *West 246* (BOL, GRA).

-3326 (Grahamstown): Riebeck East (--AA), 19-10-1974, *Bayliss 6860* (K); near Grahamstown (--BC), 10-11-1867, *Macowan 818* (K, NH, SAM); Signal Hill (--BC), 10-1897, *Thode 6076* (STE); West Hill, Albany (--BC), 11-1926, *Dyer 662* (GRA, L);Grahamstown (--BC), 10-1908, *Daly* s.n. (PRE 12448); near Grahamstown (--BC), *Macowan 1083* (BOL); Stockenstown, Katberg (--BC), 11-1926, *Lotsy & Goddjin 669, 1091* (L); Reed Valley, Alexandria (--DA), 23-10-1953, *Archibald 5317* (G, K, PRE).

-3418 (Simontown): Kirstenbosch (--AB), 28-10-1944, *Henderson 2162* (NBG); 11-1919, *Verdoorn* s.n. (PRE 55318); 17-10-1979, *Malan* s.n. (PRE, NBG); Bergvliet Farm (--AB),

15-10-1915, *Purcell* s.n. (SAM); Froggy Farm (--AB), 5-10-1971, *Taylor 7934* (K, PRE, STE); Simon's Bay (--AB), 9-1865, *Wright 582* (L 301280, P, PRE, TCD); Suther Peak (--AB), 19-10-1986, *Stirton 11207* (K, NBG); Llandudno (--AB), 18-9-1943, *Compton 14821* (NBG); Wynberg (--AB), 10-1916, *Arbuthnot* s.n. (STE 24866); Somerset West, Vergelegen (--BB), 18-10-1963, *Johnson* s.n. (NBG); Somerset West, Morning Star Farm (--BB), 30-10-1952, *Parker 4822* (K, NBG); between Van der Stel and Strand (--BB), *Phillips* s.n. (SAM 28313); Strand (--BB, 3-10-1946, *Parker 4144* (NBG); Somerset Strand (--BB); 11 = 1919, *Rogers 17674* (G, K); Gordons Bay (--BB), 60-10-1986, *Vlok 1643* (NU, SAAS); Sir Lowrys Pass (--BB), 9-11-1897, *Galpin 3962* (PRE); 20-10-1951, *Maguire 1066* (NBG); Simonsberg, E slopes (--DD), 14-10-1950, *Gray* s.n. (BOL).

-3419 (Caledon): 12 km east from Grabow (--AA), 20-10-1951, *Maguire 1080* (NBG); Howhoek (--AA), 14-10-1894, *Schlechter 5440* (G, K, MEL, NBG, PRE, STE, W); Caledon (--AB), 11-1947, *Liebenberg 4041* (STE); Elephant Rock (--AC), 28-11-1983, *Drewe 155* (HER); Onrust (--AC), 24-9-1938, *Gillett 4398* (K); Vermont on Hermanus Coast (--AC), 7-10-1938, *Gillett 4487* (BOL, K, PRE); Klippiesbaai, Volklip (--AD), 21-10-1980, *Williams S.L. 534* (HER); east of Vogelgat River (--AD), 26-11-1984, *Williams S.L. 1077* (HER); Fernkloof Nature Reserve (--AD), 28-10-1983, *Drewe 41* (K, MO).

-3420 (Bredasdorp): Rolandale, 5 km E of Swellendam (--AB), 21-10-1976, *Thompson 3278* (STE); Swellendam (--AB), *Kennedy* s.n. (PRE); Levskraal, Zondereindrivier (--AB), 19-11-1894, *Penther 2575* (W); North of Heidelbergon road to Goedehoop (--BB), 2-10-1986, *Goldblatt 7949, 7954* (MO).

-3421 (Riversdale): Corenti River Farm (--AA), 12-1908, *Muir 5085* (GRA, PRE); Reisiesbaan Siding W (--AB), 31-10-1979, *Bohnen 708/1* (PRE); Albertinia (--BA), 11-1914, *Muir 1818* (PRE).

-3422 (Mossel Bay): Belvedere Hills, Knysna (--BB), 11-1928, *Fourcade 4146* (K).

-3423 (Knysna): Witte drift road, 1,3 km from Knysna road (--AB), 28-10-1943, *Fourcade 6207* (BOL); Hills east of Keurbooms River (--AB), 8-11-1925, *Hutchinson 1368* (BOL, PRE, K).

-3424 (Humansdorp): Driefontein road, ca. 2 miles from National road (--AB), 11-1942, *Fourcade 5817* (STE); Humansdorp (--BB), *Bolus 2294* (K); 20-11-1972, *Dixon 145* (STE); flats above Humansdorp (--BB), 7-11-1942, *Fourcade 5812* (STE).

Without precise locality: Cape, 1826, *Bauer* s.n. (W); Cape, *Bowie* s.n. (G, K); between Mosselbay & Hout Rivier, 11-11-1814, *Burchell 6322* (K, L, W); Albany, *Bowker* s.n. (K, TCD); CBS, *Forster* s.n. (K); Cap., *Krebs 84* (G); CBS, *Pappe 24* (K); CBS, *Sieber 58* (BOL, G, GJO, K, L301280, MEL, P, PRE, W); CBS, *Verreaux* s.n. (MEL); CBS, *Wallich* s.n. (G, K, TCD); *Weiczcz* s.n. (W); *Worsdell* s.n. (K); below 10 o' clock Mountain, *Wurts 478* (NBG).

24. Otholobium bracteolatum (Eckl. & Zeyh.) C.H. Stirton in S. Afr. J. Bot. 52: 2 (1986).

Psoralea bracteolata Eckl. & Zeyh., Enum. 229 (1836). *Psoralea bracteata* L. var. *brevibracteata* E. Mey. in Linnaea 7: 165 (1832). *P. bracteata* L. var. *bracteolata* (Eckl. & Zeyh.) Harv. in Harv. & Sond., Fl. Cap. 2: 154 (1862). Holotype: "Flasche bei Doornhoogte, Stellenbosch", *Drège* s.n. (P). Ecklon & Zeyher coined a new name for this species. They did not take up Ernst Meyer's variety *brevibracteatum*.

Psoralea bracteata sensu Jacq., hort. Schoenbr. 2: 54, t.224 (1797) belongs here.

Psoralea algoensis Eckl. & Zeyh., Enum. 229 (1836). Lectotype: "in dunis arenosis ad litus sinus Algoabay prope fluminis ostium Zwartkopsrivier (Uitenhage)", *Ecklon* s.n. (S, lecto; BOL, K, MO, STE, TCD, iso).

Robust decumbent shrub or straggling subshrub to tall erect compact shrub up to 2 m tall. *Stems* few to 14, branched near the apex; bark brownish grey with grey blotches, pustulate, old branch scars prominent giving overall an undulated appearance. *Leaves* digitately trifoliolate, shortly petiolate. *Leaflets* 10 -- 20 mm long, 9 -- 13 mm wide, broadly obovate, patent mucronate, apex emarginate, base cuneate; half-conduplicate, pellucid-dotted when fresh, drying black, more or less equal on both surfaces; margin smooth, younger leaves glabrous, only the lower primary vein prominent; petiole up to 3 mm long, petiolules 1 mm long. *Stipules* up to 3 -- 5 mm long, 1,0 -- 1,5 mm wide, longer than petioles, subulate, arching outwards, margins ciliate; glandular, persistent. *Inflorescence* solitary per short shoot, in terminal axil of each shoot, compact, 20-- 25 mm long, comprised of 10 -- 15 triplets of sessile flowers, each triplet subtended by a single 5 mm long, 2,5 mm wide, ventricose, acuminate, sparsely hairy, many-nerved, glandular bract;

Fig. 9.54 *Otholobium bracteolatum*. 1, Flowering branch, x1; 2, Digitately trifoliolate leaflet, terminal showing lower surface, laterals showing upper surfaces, x3; 3, Side view of stipule, x6; 4, Apex of terminal leaflet, x8; 5, Side view of flower at anthesis, x6; 6, Standard, inner face, x5; 7, Wing petal, x5; 8, Keel petal, x5; Calyx opened out, inner face, x8; 10, Pistil, x6; 11, Flower bract, x8; 12, Fruit enclosed within calyx, x1; 13, Fruit, x12; 14, Seed, x10; 15, Triplet bract, x12 (1-4, *Van Breda 1667*, *Stirton 8403*, *9747* and photographs; 5-11, 15, *Williams 46*; 12-14, *Gillett* s.n., K).

bracts decrease in size up the axis; peduncle absent or shorter than stipules. *Flowers* 8 -- 10 mm long, bluish-purple, rarely pure white, ebracteate. *Calyx teeth* much longer than calyx tube; unequal, acute, lanceolate, tinged with purple; carinal lobe broader and longer than other lobes, 7 mm long, 1,5 mm wide; vexillar lobes fused higher up than the rest; softly hirsute, hairs white; glandular, accrescent in fruit. *Standard* 8 -- 9 mm long, 5,0 -- 5,5 mm wide, deep purple in upper two thirds of inner face, obovate, apex emarginate, scarcely reflexed, sides flared backwards, auriculate; nectar patch white flushed with purple; claw prominent, 3,0 -- 3,5 mm long, channelled; glabrous. *Wing petals* 9,5 -- 10 mm long, 2 mm wide, claw 3 -- 4 mm long, auriculate; longer than keel petals; sculpturing upper right central, comprising 10 -- 15 irregular transcostal lamellae, rows indistinct. *Keel petals* 7 -- 8 mm long, 2 mm wide, claw 5 mm long, longer than blade. *Androecium* 6 -- 7 mm long, vexillar stamen fused for basal third of its length to the sheath, sheath fused in lower half, anthers equal. *Pistil* 5 -- 6 mm long; ovary 0,75 -- 1 mm long, hairy, pubescent. *Fruit* 4 mm long, 2 mm wide, papery, reticulate, finely pubescent, enclosed by calyx at maturity. *Seeds* 2 -- 3 mm long 1,5 -- 2 mm wide, dark chesnut or black, elliptic. Fig. 9.54, 9.55, and Frontispiece.

O. bracteolatum grows in lowland fynbos at altitudes between 3 -- 400 m. It is distributed from the Cape Peninsula to as far east as Port Elizabeth (Fig. 9.56). Flowering takes place throughout the year but occurs mainly beetween October and January with peaks in November and December.

O. bracteolatum is most closely related to *O. fruticans*, *O sabulosum* and *O. parviflorum*. It is distinguished from these species by its dense erect shrubby habit, stiff bright green leaves, and flower colour. From *O. fruticans* it differs in its narrowly lanceolate flower bract and carinal tooth of the calyx, large shrubby habit, and lowland habitats. *O. fruticans* has large broadly lanceolate flower bracts and carinal calyx tooth, low speading few-branched habit and preference for montane habitats. *O. parviflorum*

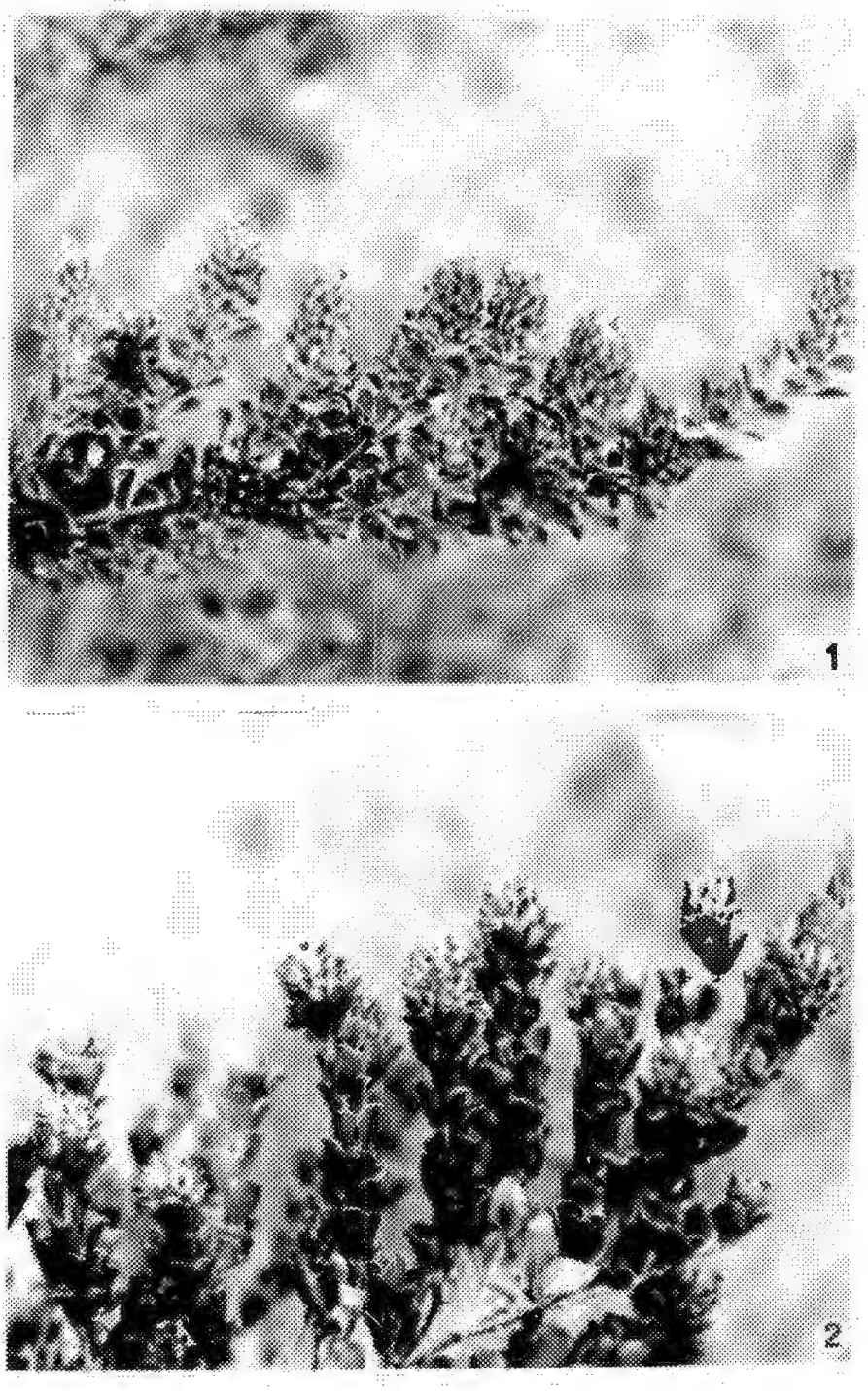


Fig. 9.55 *Otholobium bracteolatum*. Infructescences. 1, South of Kleinriviers vlei (*Stirton 9964*); 2, Driefontein, between Malgas and Bredasdorp (*Stirton 8237*).

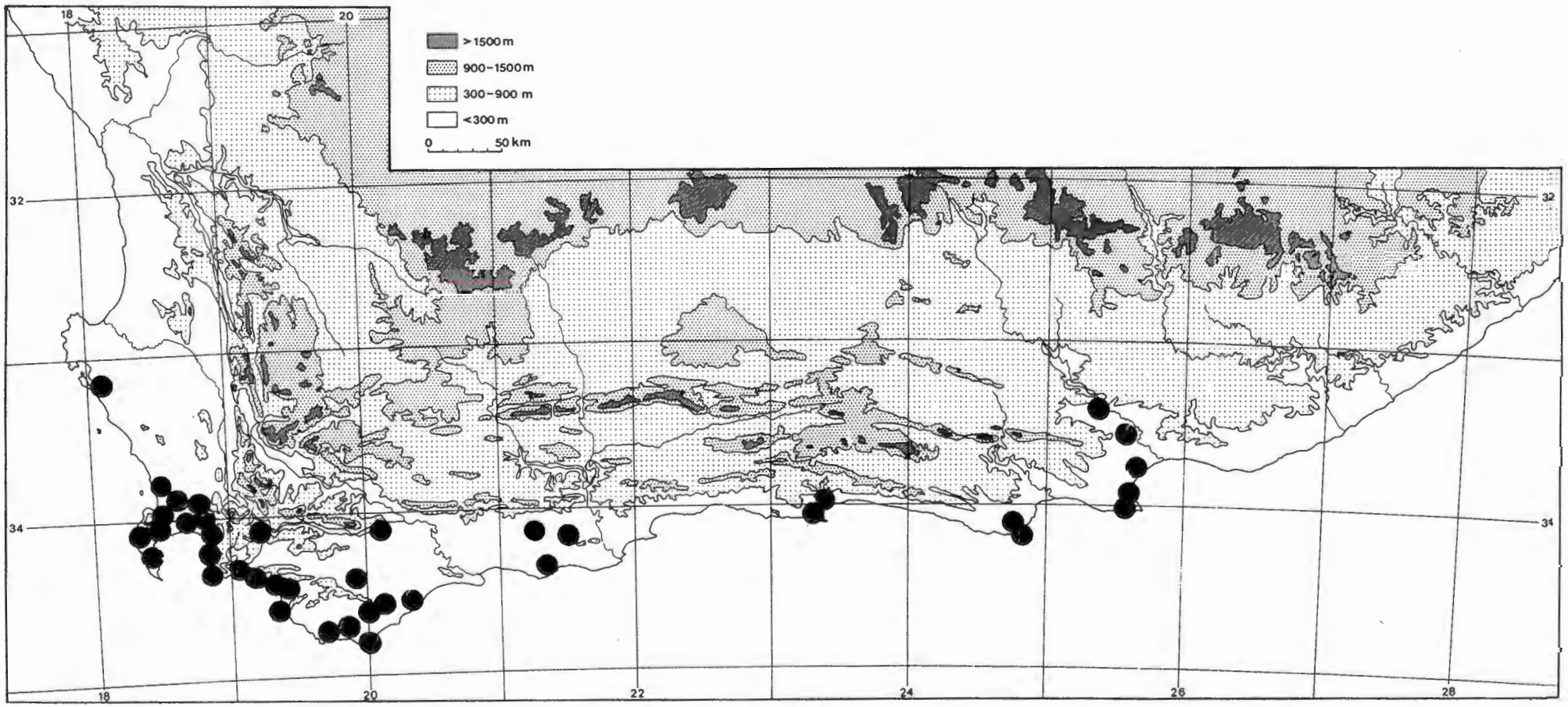


Fig. 9.56 Known distribution of *Otholobium bracteolatum* (Eckl. & Zeyh.) C.H. Stirton in southern Africa.

has elongated inflorescences and pale cream flowers. *O. sabulosum* is a dwarf calciphilous species of the Riversdale district. These four species may be keyed as follows:

1. Flowers pedicellate, calyx shorter than corolla.....2

   Flowers sessile, calyx equal in length to corolla....3

2. Branches smooth, non-pustulate, leaves subsessile; flowers maturing more or less simultaneously; ovary glabrous; calyx tube longer than calyx.....O. sabulosum

   Branches pustulate; flowers maturing sezuentially; ovary hairy; calyx tube shorter than calyx teeth.....O. bracteoaltum

3. Branches non-pustulate; lateral leaflets symmetrical; inflorescences comprised of 4 -- 9 triplets of flowers per inflorescence; peduncles overtopped by subtending leaves; style glabrous between ovary and entasis.....O. fruticans

   Branches pustulate; lateral leaflets asymmetrical; inflorescences comprised of 23 -- 25 triplets per inflorescence; peduncles overtopping subtending leaves; style hairy between ovary and entasis.....
   .....O. parviflorum

Plate t.40.17 on page 31 in Bohnen's (1986) Flowering Plants of Southern Cape, listed as *O. fruticans*, belongs to this species.

Specimens examined

-3318 (Cape Town): Geelbek Farm, south end of Langebaan lagoon (--AA), 4-12-1975, *Boucher 3012* (STE); 11 km from Melkbosstrand to Velddrif on R27 road (--CB), 18-10-1986, *Stirton 11191* (K); Melkbostrand (--CB), 12-12-1965, *Bayliss 3060* (NBG); Blaauwberg (--CB), 18-11-1974, *Lavranos 11717* (PRE); 9-12-1951, *Maguire 1277* (NBG); 17-10-1959, *Lewis 5549* (NBG); Table Mountain (--CD), *Ecklon* s.n. (K, PRE); Greenpoint (--CD), *Ecklon* s.n. (MEL 1542064, SAM 15422); below Kirstenbosch (--CD), 19-12-1927, *Young 216* (PRE); Prince Georges Drive (--CD), 14-2-1938, *Penfold* s.n. (SAM 52807); D. F. Malan Airport (--DC), 12-1956, *Stander 1* (STE); Kuils Rivier (--DC), 1-1902, *Marloth 2860* (PRE); *Zeyher* s.n. (SAM); about 12 miles from Cape Town on Cape Flats (--DC), 6-6-1948, *Clarkson 360* (BOL); Blackheath (--DC), 11-11-1972, *Bayliss 69* (PRE); 27-1-1973, *Bayliss 183* (PRE); Kuilsrivier (--DD), 8-1-1986, *Stirton 11138* (GRA, K, MO, NH, NU, PRE, STE).

-3325 (Port Elizabeth): east of Klipfontein (--AB), 4-10-1928, *Gillett 1022* (STE); Kariega Mountain (--AD), *Britten 5234* (GRA, K); on the downs by mouth of Swartkops River (--DC), *Ecklon & Zeyer 3548* (BOL, K, MEL 1542066, STE); 19-1-1953, *Archibald 4924* (GRA); Port Elizabeth (--DC), 9-1921, *Cruden 321* (PRE); 10-1895, *Kemsley 1073* (GRA, PRE); 8-11-1962, *Dahlstrand 153* (PRE); 11-1913, *Paterson 776* (GRA); 1-1957, *Sidey 3101* (PRE); 11-1908, *West 245* (BOL, GRA); Koega (--DC), 24-4-1976, *Olivier 1564* (PRE, UPE); *Laidley 180* (G).

-3326 (Grahamstown): Great Fish River, between Kaffir's Drift and Governor's Kop (--BC), *Ecklon & Zeyher* s.n. (MEL 1542057).

-3418 (Simonstown): Simonstown (--AB), *Jameson* s.n. (OXF); Simons Bay (--AB), 12-1852, *MacGillivray 487* (K); *Milne & McGillivray 162* (K); 3-11-1846, *Alexander Prior* s.n. (K); 12-12-1970, *Taylor 7854A* (STE); Hout Bay (--AB), 28-11-1897, *Galpin 3967* (PRE); 27-11-1981, *Stirton 9964* (K); Muizenburg Cemetery (--AB), 13-12-1981, *Stirton 10338*

(K, NBG); Noordhoek dunes (--AB), 28-9-1981, *Stirton 9442* (K, PRE); near Princess Vlei (--AB), 1-1920, *Marloth 9416* (PRE, STE); Dieprivier Station (--AB), 17-1-1894, *Kuntze* s.n. (K); Macassar Beach (--AB), 28-11-1965, *Taylor 6608* (K, PRE, STE); Bergvliet Farm (--AB), 11-12-1915, *Purcell* s.n. (SAM); *Purcell 329, 330, 332* (SAM); Karbonkelberg (--AB), 26-10-1940, *Kies 198* (NBG); *Heginbotham 245* (NBG); Cape Point (--AD), 30-12-1924, *Phillips* s.n. (PRE); Mitchells Plain (--BA), 7-1-1976, *Westhoff* s.n. (U); Swaelbos (--BA), 17-11-1961, *Jordaan* s.n. (STE 31256); 3 km from Strandfontein towards Swartklip (--BA), 28-2-1962, *Taylor 3182* (PRE); Kogelbaai bridge (--BB), 21-11-1969, *Boucher 907* (K, PRE, STE); Gordon's Bay (--BB), 1-1926, *Gillett* s.n. (STE 31251); Faure Flats (--BB), 18-1-1941, *Compton 10366* (NBG); Strand (--BB), *Walters 2* (PRE); Cascade Pool, Bettys Bay (--BD), *Taylor 4354* (NBG, STE); Rooi-Els River mouth (--BD), 14-7-1981, *Parsons 265* (STE); H. F. Verwoerd Reserve, Bettys Bay (--BD), 10-11-1970, *Cleghorn 2016* (PRE); Sparks Bay (--BD), 29-11-1980, *Stirton 8403* (K); South of Daskop (--BD), 5-12-1969, *Boucher 939* (STE); Cape Hangklip (--BD), 31-12-1976, *Lavranos 15179* (PRE); 23-11-1958, *L.E.Taylor 5861* (NBG).

-3419 (Caledeon): Houw Hoek (--AA), 20-11-1896, *Schlechter 9435* (K, PRE); Onrust (--AC), 18-12-1957, *Whellan 1475* (K, PRE); Hermanus (--AC), 12-1921, *Rogers 26435* (PRE); Kleinriviermond (--AD), 5-1933, *Jordaan 509* (STE); west of Mossel River, Hermanus (--AD), 30-11-1979, *Williams 46* (FNR, K, MO); south of Kleinriviersvlei (--AD), 25-11-1981, *Stirton 9952* (K, PRE); between Somerset West and Bellville (--BB), 18-12-1966, *Grobbelaar 356* (PRE); Sandbaai (--BD), 31-12-1976, *Walters 1641* (NBG); Die Mond Nature Reserve (--BD), 13-1-1981, *Stirton 11122* (K, MO, NBG, STE); Gansbaai (--CB), 28-12-1963, *Van Breda 1667* (K, PRE); 3-12-1981, *Parsons 116* (STE); 29-12-1951, *Gray* s.n. (BOL); Grootbos, Baviaansfontein (--CB), 6-10-1981, *Stirton 9747* (K); Franskraal (--CD), 30-12-1979, *Goldblatt 5356* (PRE); Baardscheerdersbosch (--DA), *Stokoe* s.n. (SAM 61586); Ratelrivier (--DA), 12-12-1896, *Schlechter 9723* (G, K, PRE);

De Poort on Elim Road (--DB), 4-12-1930, *Galpin 11200* (PRE); Cape Agulhas (--DD), 10-1940, *Esterhuyzen BOL 32217* (BOL).

-3420 (Bredasdorp): Ratelsrivier (--AA), 2-1934, *Jordaan 501* (STE); Faem Driefontein, between Bredasdorp and Malgas (--AD), 21-11-1980, *Stirton 8237* (K); Breede River mouth (--BD), 1-12-1982, *O'Callaghan 423* (STE); Bredasdorp (--CA), *Smith 4962* (PRE); 8-12-1951, *Barker 7768* (NBG); 14-8-1974, *Bayliss 920* (PRE); De Hoop (--CA), 5-2-1963, *Kruger 237* (STE); Die Mond Forestry Station (--CA), *Van Breda 1038* (PRE); Die Mond Forestry station (--CC), 14-12-1983, *De Kock 66* (STE).3421 (Riversdale): Brandfontein (--AB), 15-11-1927, *Smith 4970* (PRE); *Smith 4971* (PRE); Stilbaai (--AD), 1-10-1933, *Jordaan 520* (STE); 23-11-1978, *Bohnen 4702* (STE); 2-1909, *Muir 1982* (PRE); Ystervarkfontein near Albertinia (--BD), 2-3-1976, *Bayliss 6246* (PRE); 29-11-1966, *Bayliss 3771* (NBG); 11-12-1978, *Bayliss 8969* (G).

-3423 (Knysna): 12 km east of Plettenberg Bay (--AB), 6-12-1961, *Barclay and Acocks 940* (US).3424 (Humansdorp): Humansdorp (--BB), 11-1909, *Christie 52* (NH); Cape St Francis Nature Reserve (--BB), 17-3-1979, *Cowling 29* (GRA); Jeffreys Bay (--BB), 13-11-1928, *Hutchinson 1457* (BOL, K,).

-3425 (Skoenmakerskop): Cape Recife (--BA), 24-12-1813, *Burchell 4396* (K); 6-12-1936, *Long 1406* (K).

Without precise locality: 1836, *Drge* s.n. (K); *Bowie* s.n. (G); Kelders, 30-12-1940, *Compton 10202* (NBG); Cape Flats, *Ecklon and Zeyher 3550* (BOL, MEL 1542053, SAM 15921); Ratels Bosch, 8-1905, *Fourcade 37* (GRA); Orangerie, 30-6-1819, *Gay* s.n. (K); C.B.S., *Harvey 700* (TCD), *702, 780* (K); Cape Flats, *Krauss 896* (TUB); CBS, H.M.S. Herald, 1852, *Milne* s.n. (MEL 1542054); C.B.S. *Pappe* s.n. (K); *Persoon* s.n. (L 901280); Sandhoogte, 15-11-1927, *Smith 4929* (PRE); C.B.S., *Thom 964* (K).

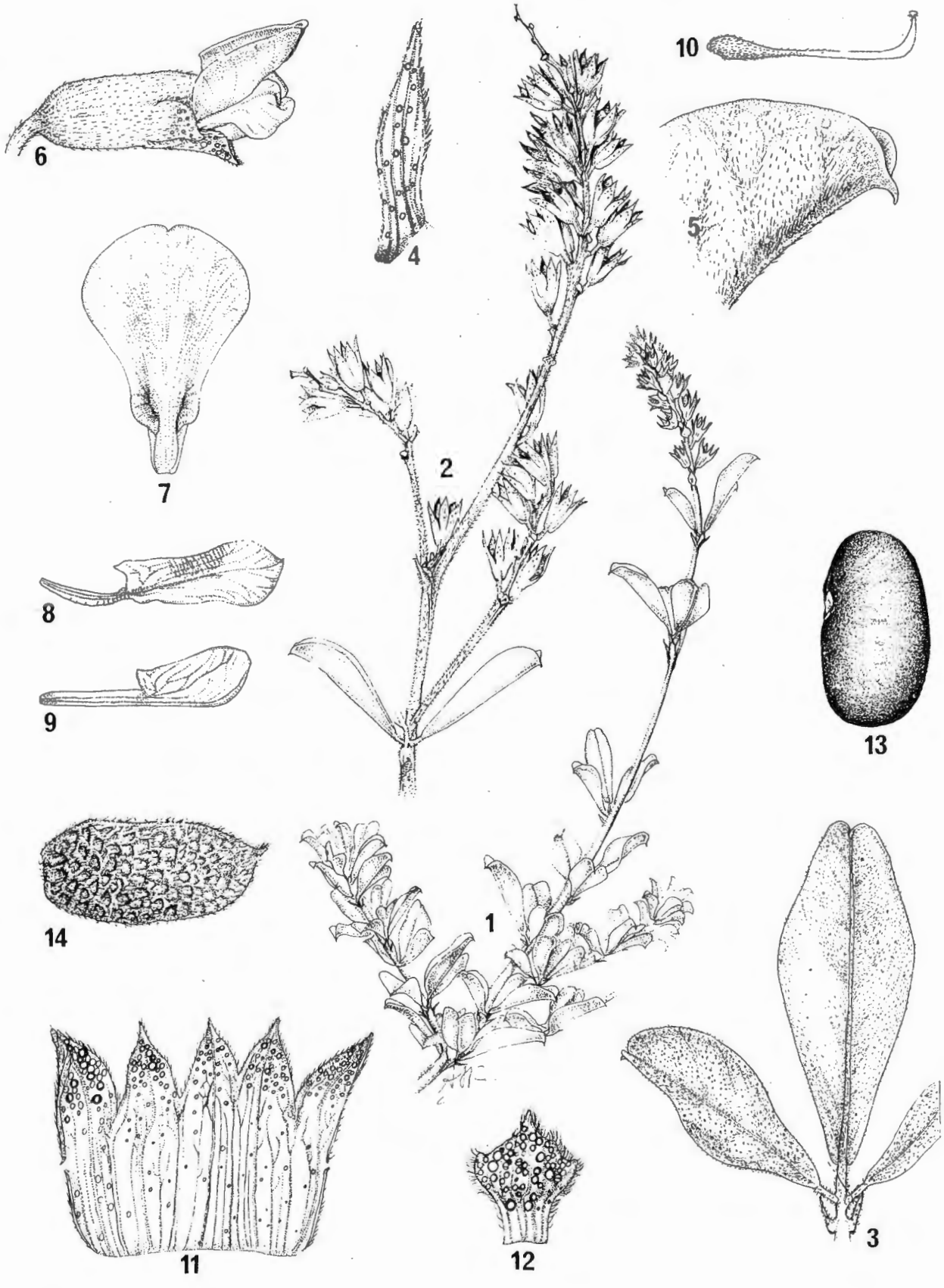


Fig. 9.57 *Otholobium striatum*. 1, Fruiting shoot, x$^1/_2$; 2, Close-up of infructescences, x1; 3, Pinnately trifoliolate leaflet, terminal showing lower surface, laterals showing upper surfaces, x1,5; 4, Stipule, 6; 5, Apex of terminal leaflet, x4; 6, Flower, x6,5; 7, Standard, x5; 8, Wing petal, x5; 9, Keel petal, x5; 10, Pistil, x110; Calyx opened out, inner face, x7; 12, Triplet bract, x8; 13, Seed, x6,5; 14; Fruit, x6,5 (1-12, *Drège* s.n., K; 13-14, *Stirton 8447*).

long. **Stipules** 4 -- 6 mm long, subulate, spreading, arcuate. **Inflorescenses** spicate, terminal on 5 -- 15 cm long densely leafy seasonal shoots; peduncle <10 mm long; scarcely overtopping the leaves; dense, comprised of 9 -- 16 triplets of shortly pedicellate flowers; each triplet subtended by a flabellate, cucullate, puberulent, densely glandular, 3 -- 4 mm long, 2 mm wide, caducous bract. **Flowers** 7 -- 8 mm long, ebracteate. **Calyx teeth** shorter than the tube, ovate to ovate lanceolate, subequal, lobes 6 -- 7 mm long, tube 4 mm long; carinal lobe shortest but slightly wider, vexillar lobes fused for 2 mm above the tube; cano-pubescent; glandular over the whole surface, but denser on teeth, glands variously sized; calyces accrescent in fruit. **Standard** 7 mm long, 5,0 -- 5,5 mm wide, claw 2 -- 3 mm long, obovate, apex emarginate, scarcely auriculate, shorter than the wing petals. **Wing petals** 7 -- 8 mm long, 2,0 -- 2,5 mm wide, claw 3 -- 4 mm long, longer than standard and keel petals, distinctly auriculate; sculpturing upper central, comprising 13 -- 16 irregular rows of transcostal lamellae. **Keel petals** 7 mm long, 2 mm wide, claw 4 mm long. **Androecium** 6,5 -- 7,0 mm long, vexillar stamen lightly adherent to lower third of the left side of the adaxially slit sheath. **Pistil** 6,0 -- 6,5 mm long; ovary 2 mm long, pilose; height of curvature 1,5 mm, style thickened, mostly just before the point of flexure, upper part beyond the entasis somewhat forward sloping, stigma penicillate. **Fruit** membranous, 7 mm long, 4 mm wide, completely enclosed in accrescent calyx, oblong, pubescent, distinctly reticulate, eglandular. **Seed** 4 mm long, 3 mm wide, black, hilum nearly central. Fig. 9.57 & 9.58.

O. striatum appears to occur in disturbed areas and in Central Mountain Renosterveld (Fig. 9.59). It occurs at altitudes between 300 -- 1100m. Flowering takes place from September to December with a peak in November.

Fig. 9.58 *Otholobium striatum*. 1, Flowering shoots of *Stirton 10160*; 2, Erect, much branched shrub, may form treelets (*Stirton 10161*); 3, Inflorescence, notice characteristic recurvature of the calyx teeth (*Stirton 10160*).

This species is closely related to *O. arborescens* (See under *O. arborescens* for a discussion of both species). Its glaucous foliage, yellow flowers and congested foliage is distinctive. It is often the most dominant shrub wherever it is found. The flowers have a sweetish smell and are much favoured by small bees.

Specimens examined

-3119 (Calvinia): below escarpment west of Nieuwoudtville (--AC), 5-12-1981, *Stirton 10160* (K, PRE); Bokfontein, between Groenrivier and Waterval (--AB), *Drege* s.n. (G, GBH, K, P, PRE, W); Lokenburg (--CA), 11-1919, *Acocks 17475* (K, PRE); Botterkloof (--CD), 5-12-1981, *Stirton 10161* (K, PRE).

-3219 (Wuppertal): Wuppertal (--AC), 11-1929, *Thode 1994* (K, PRE); 10 km from Grootrivier to Op-die-Berg (--CD), 8-9-1984, *Stirton 10690* (K, PRE); Zonderwater (--CD), 29-8-1976, *Stirton 5904* (K, PRE).

-3319 (Worcester): Artoislooprivier (--AC), 2-12-1980, *Stirton 8447* (K); Romansrivier (--AC), 4-12-1981, *Stirton 10125* (K); Ceres Road (--AC), 10-11-1896, *Schlechter 9077* (G); 10-12-1896, *Schlechter 9174* (BOL, K, P, PRE, W); 5 km from Agter Witzenberg to Citrusdal (--AD), 9-11-1986, *Stirton & Zantovska 11511* (K); Hottentots Kloof (--BC), 29-11-1939, *Bond 23* (BOL, NBG, PRE); south end of Bainskloof Pass (--CA), 9-11-1986, *Stirton & Zantovska 11512* (K, NBG); 30-6-1940, *Esterhuysen 2595* (BOL); Worcester (--CB), 12-11-1925, *Marloth 12565* (PRE, STE); 5-3-1976, *Bayliss 6276* (PRE); Brewelskloof (--CB), 22-12-1976, *Bayer 308* (NBG); 33,7 km from Montagu to Touwsrivier (--DB), 20-11-1984, *Grobbelaar 2860* (PRE); Jonaskop (--DC), 28-11-1974, *Bayliss 6977* (GRA, K, NBG, PRE, US); 30-11-1976, *Walters 1599* (NBG).

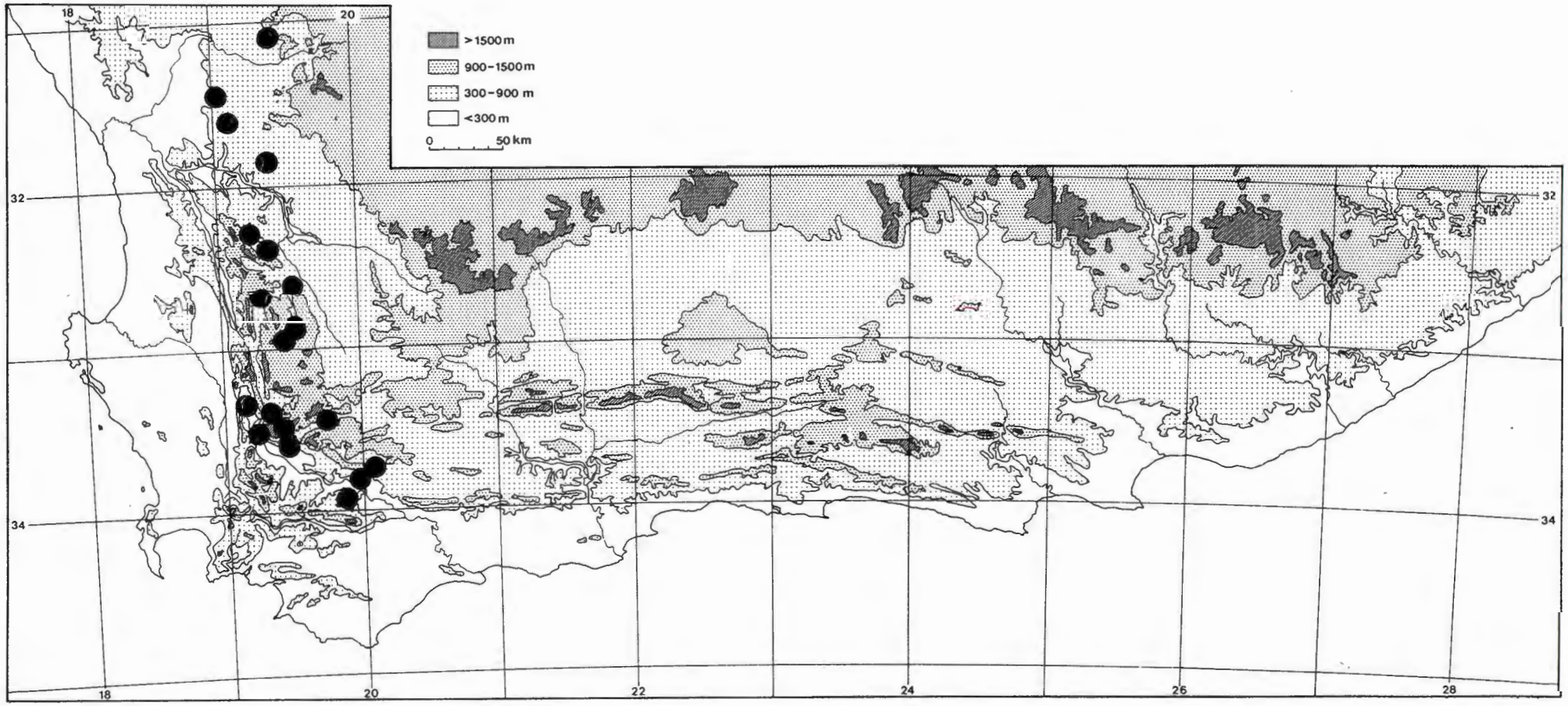


Fig. 9.59 Known distribution of *Otholobium striatum* (Thunb.) C.H. Stirton in southern Africa.

-3320 (Montagu): Zandleegte (--CC), 6-1945, *Levyns 7705* (BOL).

Without precise locality: 1802, *Thom 354* (K); S. Africa, *Zeyher* s.n. (G, GBH, K, MEL).

26. Otholobium trianthum (E. Mey.) C.H. Stirton in S. Afr. J. Bot. 52: 4 (1987).

Psoralea triantha E. Mey., Comm. 88 (1836); Walp., Repert. 1: 658 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 150 (1862); Forbes in Bothalia 3: 123 (1930); Adamson & Salter, Fl. Cape Penins. 487 (1950). Lectotype: "Locos humidis ad Bergrivier" *Drège* s.n. (K, lecto; BM, BOL, P, W, iso). Syntypes: "In collibus prope Lauwskloof", *Drège* s.n. (W). I have not come across any of the following syntypes; "In arenosis ad Breederivier", *Drège* s.n.; "in fruticetis ad Zwartkopsrivier", *Drège* s.n.

P. triflora Poir. in Lam., Encycl. 5: 683 (1804) non Thunb. (1800). Poiret cites specimens from Herb. Juss. and from Herb. Lam. His concept of the species is confused and seems to combine elements of *O. candicans* (Herb. Juss.) and *O. trianthum* (Herb. Lam. and Herb. Juss.)

Erect, slender shrub up to 2 m tall. **Stems** rigid; branches virgate, ramuliferous, tomentulose. **Leaves** pinnately trifoliolate, shortly petiolate. **Leaflets** (5) 15 -- 20 (25) mm long, 2,0 -- 2,5 mm wide; laterals smaller, linear to narrowly oblanceolate, spreading; apex emarginate, recurved-mucronulate, mucro straight, base cuneate; glands numerous, crateriform, variously sized, reddish-brown in dried material; young leaflets sparsely sericeous on midrib below and along margins, glabrescent; petiole 2 -- 3 mm long, petiolule 1 mm long, rachis <1 mm long. **Stipules** 2,0 -- 2,5 mm long, acuminate, persistent, glandular, clasping; fused very low down on the petiole. **Inflorescence** axillary and terminal, numerous, up to 14 per seasonal shoot, crowded into a cylindrical or interrupted pseudoraceme, peduncle equal to petiole, comprised of 1 -- 3 triplets of pedicellate flowers; pedicels 1 mm long; each triplet subtended by a rectangular, irregularly toothed, glandular, <1 mm long bract. **Flowers** 6 -- 8 mm long, flower colour unknown; each flower subtended by a setaceous to lanceolate, 2 -- 3 mm long bract. **Calyx** lobes 5

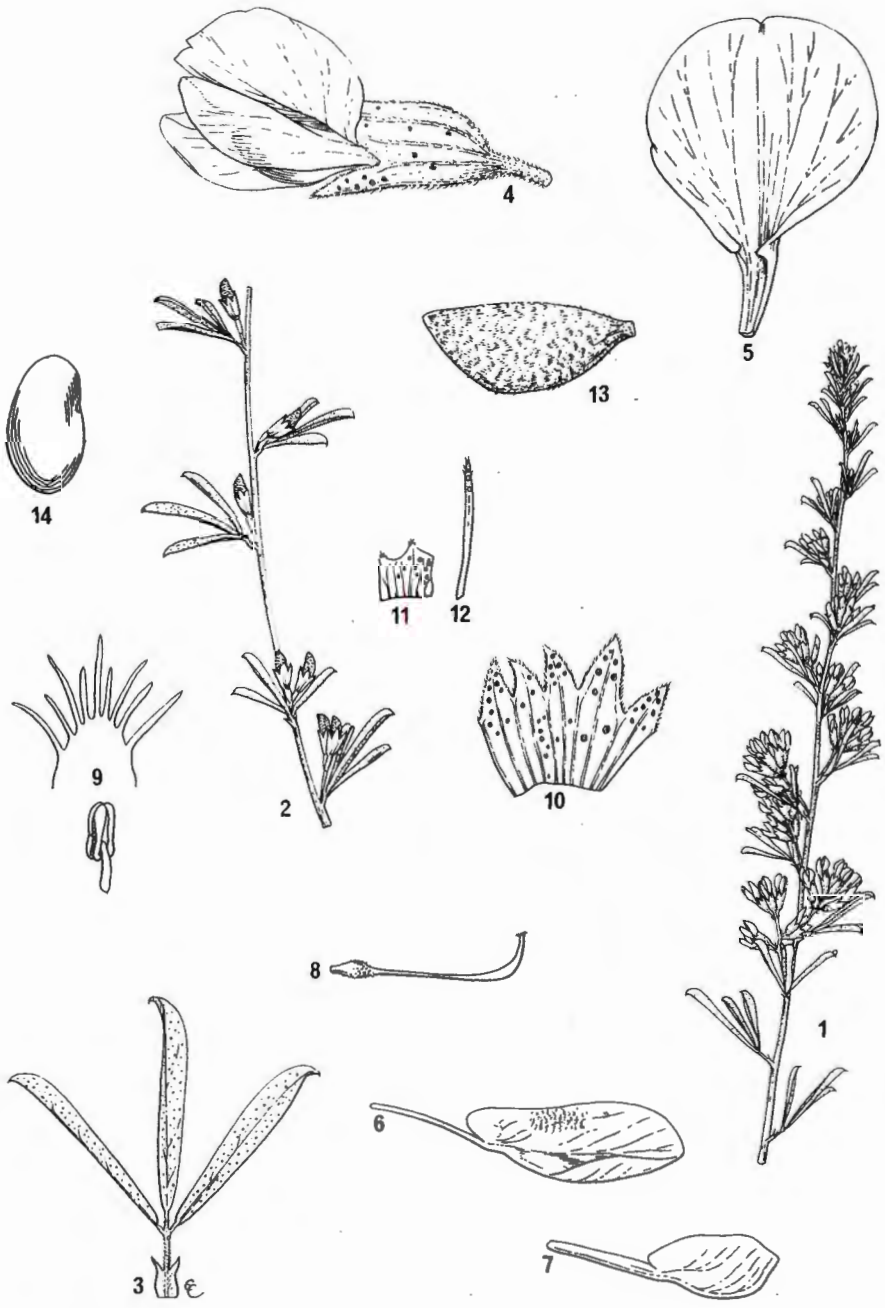


Fig. 9.60 *Otholobium trianthum*. 1, Flowering shoot, $x^2/_3$; 2, Portion of fruiting shoot, $x^2/_3$; 3, Pinnately trifoliolate leaflet, x3; 4, Flower, x7,5; 5, Standard, 7,5; 6, Wing petal, x7,5; 7, Wing petal, x7,5; 8, Pistil, x7,5; 9, Upper part of filaments and one representative anther, x15; 10, Calyx opened out, inner face, x 7,5; 11, Triplet bract, x15; 12, Flower bract, x15; 13, Fruit, x5; 14, Seed, x15 (1,3-14, *Salter 5679*, 2, *Leipoldt 4386*).

-- 6 mm long, tube 3 mm long, longer than the short triangular teeth; carinal lobe larger and slightly broader than the rest; ribbed; appressedly puberulent, glands prominent, mostly on the teeth, variously sized; accrescent. **Standard** 8 -- 9 mm long, 5,0 -- 6,5 mm wide, claw 3,0 -- 3,5 mm long, obovate to oblong-ovate, emarginate, auriculate. **Wing petals** 4 -- 6 mm long, 2,5 -- 3,0 mm wide, claw 3 mm long, fused to and longer than keel petals; auriculate, sculpturing upper basal, faint, comprised of up to 12 curving transcostal lamellae. **Keel petals** 3 -- 6 mm long, 1,5 -- 2,0 mm wide, claw 2,5 -- 3,0 mm long. **Androecium** 6 mm long; vexillar stamen free, base flattened, rugose. **Pistil** 5 mm; ovary 1 mm long, shortly stipitate, glandular, few haired; height of curvature 1,2 -- 1,5 mm, entasis broadest at point of flexure. **Fruit** 12,5 -- 13,0 mm long, 4 mm wide, leathery, appressed puberulent, gland-dotted, much exceeding the calyx, coarsely reticulate. **Seeds** 4 mm long, 3 mm wide, narrow; chestnut-brown, hilum between centre and apex. Fig. 9.60.

Otholobium trianthum is an occasional Namaqualand species (Fig. 9.61) which favours sandy sites between the altitudes of 100 -- 400 m. Flowering takes place between November and January with a peak in December. Very little is known about this species.

Specimens examined

-3218 (Clanwilliam): Banks of Olifants River at Clanwilliam (--BB), 12-1897, *Leipoldt 632* (BOL, NBG, PRE, SAM); Sandkraal, on Olifants River, 6 miles NW of Clanwilliam (--BB), 18-1-1947, *Leipoldt 4386* (BOL, K); Elandsfontein (--BB), 29-1-1949, *Van Breda 236* (PRE); Boschkloof, Blaauberg (--DB), *Drege* s.n. (G, SAM 15411).

-3219 (Wuppertal): Cedarberg (--AC), 12-1934, *Leighton* s.n. (K, PRE 21512); Uitkyk Pass (--AC), 12-1934, *Leipoldt* s.n. (BOL 21512).

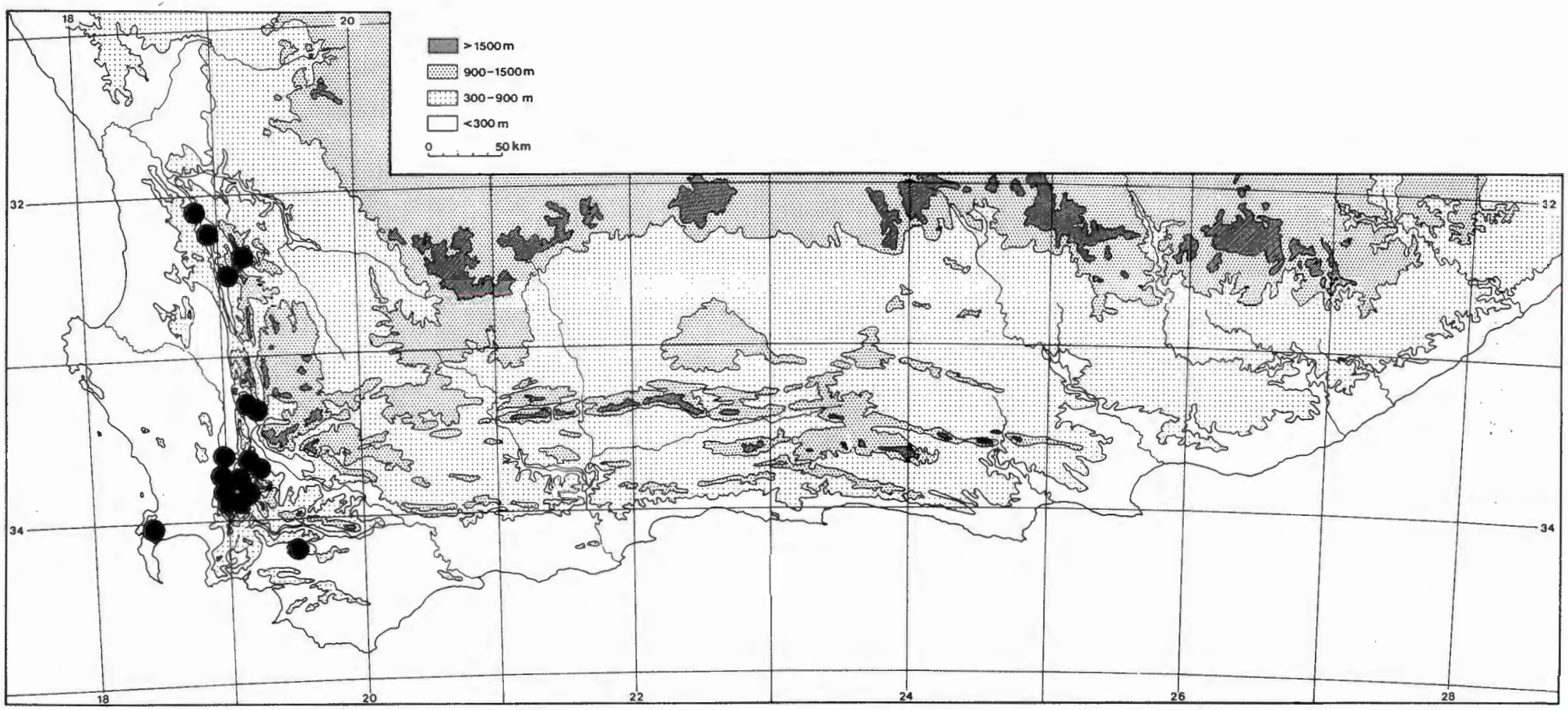


Fig. 9.61 Known distribution of *Otholobium trianthum* (E. Mey.) C.H. Stirton in southern Africa.

-3318 (Cape Town): Paarl (--DB), *Hutt* s.n. (TCD); Dwars River (--DB), 9-1-1892, *Schlechter 202* (BOL,, G, GRA, PRE, W); Banks of Berg River (--DD), 1847, *Alexander 146* (K); Groot Drakenstein (--DD), 1-1920, *Marloth 9439* (AA, PRE, STE).

-3319 (Worcester): Smith's Farm, Tulbagh (--AC), *Guthrie 3110* (NBG); near Claremont (--AC), 22-11-1935, *Salter 5679* (BOL, K); Witzenberg, Tulbagh (--AC), *Zeyher 446* (G, GH, K, Mel 1542091, SAM 49216); Klein Drakenstein (--CA), *Drège* s.n. (TUB); Haelsneeukop (--CA), 12-1944, *Stokoe* s.n. (SAM 56317); Du Toits Kloof (--CA), 1-1882, *Tyson 877* (BOL); Wemmershoek, Paarl (--CC), 14-12-1940, *Bond 724* (NBG); 14-12 1940, *Esterhuysen 4029* (BOL, GRA, PRE); Franschhoek Mountains (--CC), 11-2-1897, *Schlechter 10268* (BOL); *Drège* s.n. (G, K, PRE, TCD).

Without precise locality: Caledon Mountains, 1847, *Alexander 84* (K); South Africa, *Langley-Kitching* s.n. (K); Meirings Poort, 2-1926, *Leipoldt* s.n. (BOL, MO, PRE); Cape, *Verraux* s.n. (G); Clanwilliam district, *Zeyher* s.n. (SAM 49215).

27. Otholobium pustulatum C.H. Stirton, *sp. nov., O. flexuosi affinis sed habitu humile implexo, folia plana sericea trifoliolata, stipulis multo longioribus setaceis calyce multo maiore et in forma dissimili differt.*

Typus: 2917 (Springbok): 27 km SWW of Springbok, 24-9-1957, *Acocks 19581* (PRE, holo; K, iso).

Frutex implexus usque 1 m altus. Rami atrobrunnei pustulati, sparse lenticellati, juventute appresse puberuli. Folia trifoliolata, petiolata. Foliola inaequales; terminale (12) 15 -- 16 mm longa, 5,0 -- 6,5 mm lata, quam lateralia maius, omnia symmetrica; recurvato-mucronata, apice emarginata, base cuneata, plana, rare complicata, utrinque sparsim sericea; petiolus 2 - 4 mm longus, post casum foliolorum persistens; petioluli < 1mm longi, sericei. Stipulae 2,0 -- 3,5 mm longae, setaceae, rectae, caducae. Inflorescentiae in ramulis annuis longis usque 30 cm, rectis arcuatisive sparse foliosis terminales, partim congestae, 30 -- 45 mm longae, floribus brevipedicellatis ascendentibus in 5 -- 8 gregibus trifloris aggregatis, grege omni a bractea mox caduca pubescenti subtenta. Flores 8 -- 9 mm longi, ebracteati, albi; pedicellus <2 mm longus. Dentes calycis tubus 3 mm longus multo excedentes, aequales vel subaequales (dente carinali interdum maiore), lanceolati, dente carinalis latiore, 2 mm lato; appresse puberuli atri, ubique copiose regulariter glandulosi. Vexillum 9 -- 10 mm longum, 6 -- 7 mm latum, obovatum. Alae 9 -- 10 mm longae, 2,5 -- 3,0 mm latae quam carina multo longiores. Petala carinae 7 mm longa, 2,0 -- 2,3 mm lata. Androecium 8 mm longum, vagina adaxialiter fissa; stamen decimum in tertio inferiore leviter connatum. Pistillum 7 mm longum; ovarium 2 mm longum in dimiduo superiore sericeum, parte curvata, 2 mm alta; entase ad partem curvatam incrassato; stigma penicillatum. Fructus seminaque ignoti.

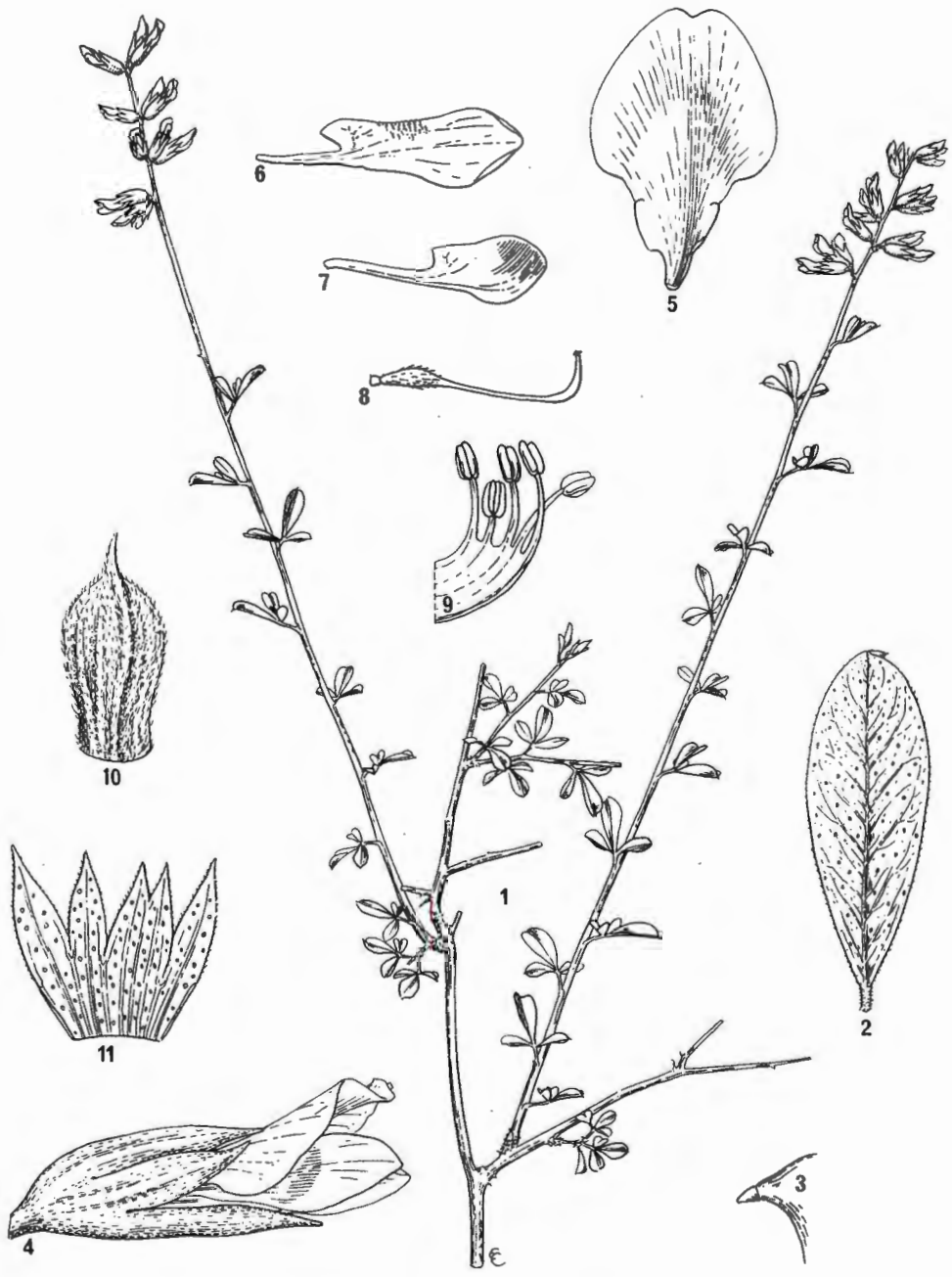


Fig. 9.62 *Otholobium pustulatum*. 1, Flowering branches, $x^4/_5$; 2, Terminal leaflet, x4; 3, Apex of terminal leaflet, x18; 4, Flower, x6; 5, Standard, x5; 6, Wing petal, x5; 7, Keel petal, x5; 8, Pistil, x5; 9, Upper part of filaments with half removed to show insertion, x20; 10, Triplet bract, x12; 11, Calyx opened out, inner face, x5 (*Acocks 19581*).

Tangled shrub up to 1 m high. **Branches** brownish-black, pustulate, sparsely lenticelled, appressedly puberulous when younger. **Leaves** pinnately trifoliolate, petiolate. **Leaflets** unequal; terminal (12) 15 -- 16 mm long, 5,0 -- 6,5 mm wide, obovate, larger than the laterals, all symmetrical; recurved mucronate, mucro 0,5 mm long; apex emarginate, base cuneate, flat to partly complicate, sparsely sericeous on both surfaces; petiole 2 -- 4 mm long, persistent once leaflets have dropped; petiolules <1 mm long, sericeous. **Stipules** 2 -- 3,5 mm long, glabrous, setaceous, straight, caducous. **Inflorescences** terminal on long straight or arching, sparsely leafy, seasonal shoots up to 30 cm long; partly congested, 30 -- 45 mm long, flowers ascending; comprised of 5 -- 8 triplets of shortly pedicellate flowers, each triplet subtended by a rapidly caducous pubescent bract. **Flowers** 8 -- 9 mm long, ebracteate, white; pedicel <2 mm long. **Calyx teeth** much longer than the 3 mm long tube; equal to subequal (carinal tooth sometimes longer); lanceolate, carinal tooth slightly broader, 2 mm wide; vexillar teeth fused for more than half their length, appressedly puberulous, blackish, profusely and evenly glandular over the entire surface. **Standard** 9 -- 10 mm long, 6 -- 7 mm wide, broadly ovate; apex emarginate, claw 2 mm long, scarcely auriculate. **Wing petals** 9 -- 10 mm long, 2,5 -- 3,0 mm wide, claw 4 mm long, auricle prominent, much longer than the keel petals; sculpturing upper central comprising up to 15 rows of transcostal lamellae. **Keel petals** 7 mm long, 2,0 -- 2,3 mm wide, claw 3 -- 4 mm long, apex obtuse. **Androecium** 8 mm long, sheath split adaxially, vexillar stamen lightly fused in lower third. **Pistil** 7 mm long; ovary 2 mm long; sericeous on upper half, stipitate; height of curvature 2 mm, entasis broadest at point of curvature; stigma penicillate. **Fruits** and seeds unknown. Fig. 9.62.

O. pustulatum occurs in mountain Renosterveld (Acock's Veld Type No. 43) at an altitude of 700 -- 800 m. (Fig. 9.62). Flowering takes place in September and October.

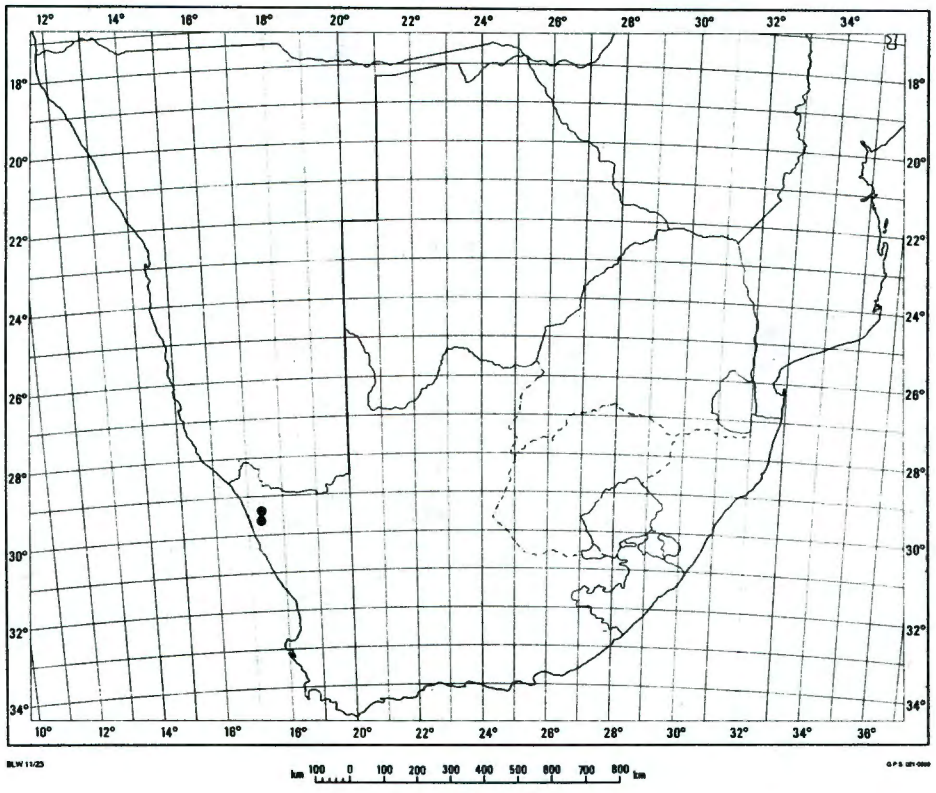


Fig. 9.63 Known distribution of *Otholobium pustulatum* C.H. Stirton in southern Africa.

O. pustulatum is most closely related to *O. flexuosum* but differs from that species in its low tangled habit; flat sericeous trifoliate leaves, much longer setaceous stipules, more compact inflorescences and much larger and differently shaped calyx. *O. flexuosum* is a more robust shrub with digitately trifoliolate complicate leaves sparsely sericeous on lower surface only, nitid above; small stipules; lax zig-zag like inflorescences; and short-toothed calyces. *O. venustum* differs in its auriculate standard, narrowly obovate to narrowly oblong arching leaflets, pink to mauve flowers, and glabrous ovary.

Specimens examined

-2917 (Springbok): 24 km south-west of Springbok (-AD), 24-9-1957, *Acocks 19581* (K, PRE); Kammagas (-CB), 1-10-1929, *Herre* s.n. (STE); Spektakel Pass (-DA), 4-9-1951, *Maguire 1009* (NBG).

Without precise locality: Namaqualand, *Whitehead 26* (MEL 1541978).

28. Otholobium pungens C.H. Stirton in Bothalia 14: 72 (1983). Holotype: Potberg North, *Acocks 22835* (K, holo; PRE, iso).

Spreading, decumbent, much-branched woody shrublets; old branches blackish but puckered with distinctive rectangular bands of grey-white lenticels, glabrous; young branches green, sparsely pilose, finely ribbed. **Stems** 2 -- 10, up to 30 cm long. **Stipules** fused, adnate to the base of the petiole, 3 -- 4 mm long, 1,5 -- 2,0 mm wide, broadly and obliquely ovate, acute, striate, glabrous inside, sparingly white pubescent outside towards the base, otherwise glabrous, margins ciliate. **Leaves** trifoliate, subdigitate, petiolate. **Leaflets** 8 -- 10 mm long, 2,5 --13,0 mm wide, oblanceolate, rarely elliptic, base cuneate, apex sharply pungent, rarely recurved, shiny, glabrous except for younger leaves which are sparingly hairy along the midrib and margins, sparingly covered in large spherical internal pellucid glands prominent when seen from above; lateral leaflets smaller, excentric; petiole 2,5 -- 4,0 mm long, petiolules very short. **Inflorescences** axillary, 3- rarely 2-flowered, clustered towards the ends of branches, shortly pedunculate, each inflorescence subtended by a 2,5 -- 4,0 mm long, glabrous, toothed, obovate bract with ciliate margins; pedicels 2 -- 3 mm long. **Flowers** 9 -- 11 mm long, 4 -- 5 mm wide, pale violet, each subtended by a 4 mm long, linear bract, ebracteolate. **Calyx tube** 3 mm long, lobes 6 -- 7 mm long, each tooth prominently 3-ribbed, all lanceolate except the broadly ovate, glandular and pungent keel lobe, hairy along the ribs and on the tube, inner face of teeth finely pubescent; accrescent. **Standard** 12 mm long, 11 mm wide, broadly-obovate, auriculate, appendages absent, claw 3 mm long, apex emarginate, only sides of the standard reflexed. **Wing petals** 11 mm long, 4 mm wide, cultrate, auriculate, sculpturing upper basal comprised of 9 recurved lamellae. **Keel petals** 7 mm long, 2 mm wide, purple-tipped, shorter than wing petals. **Androecium** 6 mm long, vexillar stamen free, anthers uniform. **Pistil** 5,5 mm long, glabrous, ovary 3 mm long, sessile, sparsely covered with recurved club-shaped glands; style gently upcurved, swollen at point of curvature, height of curvature 2,5 mm; stigma oblique, penicillate. **Fruits** papery, 4 mm

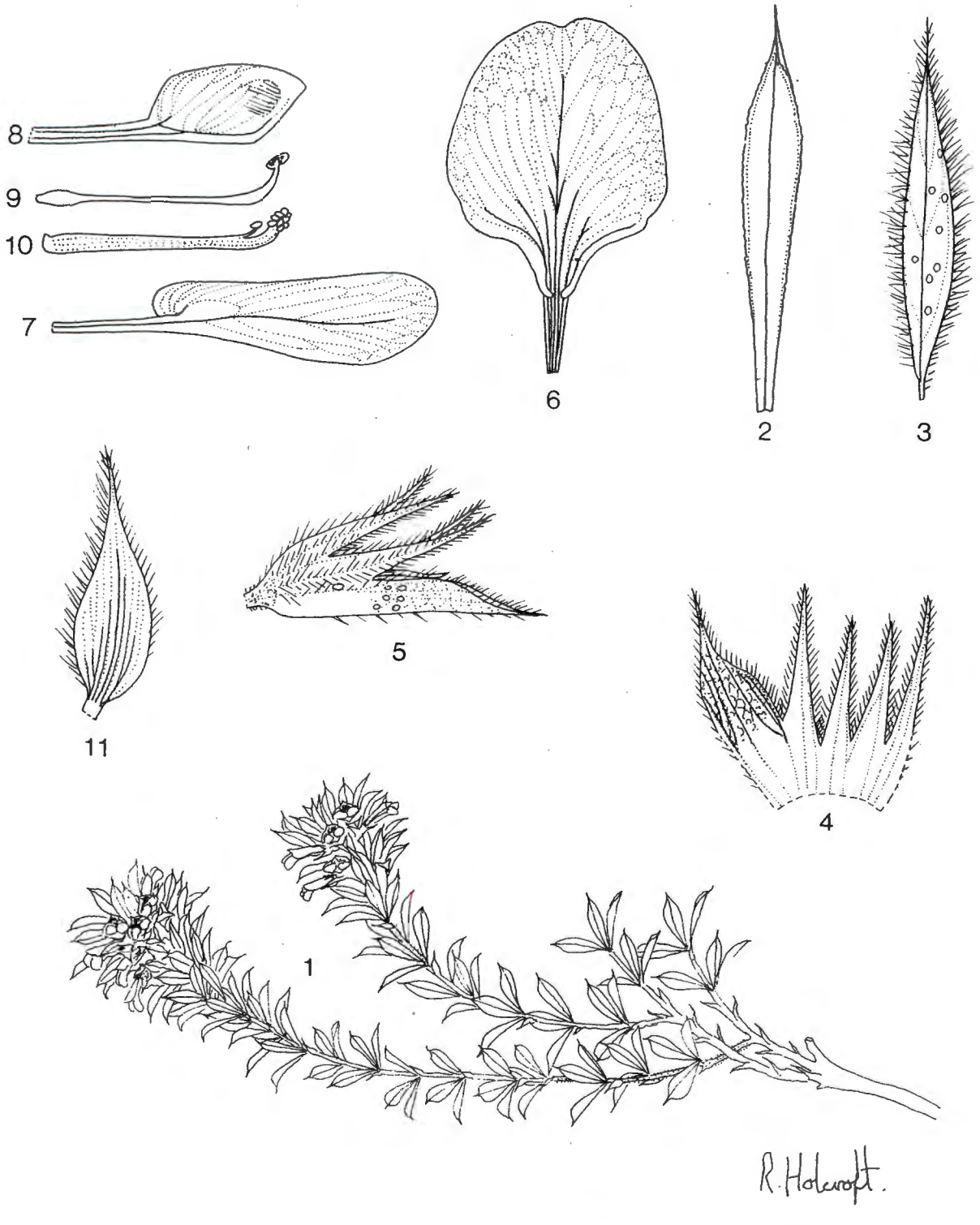


FIG. 9.64. *Otholobium pungens*. 1, habit × 1; 2, terminal leaflet, × 6; 3, lateral leaflet, × 6; 4; calyx opened out, × 4; 5, calyx closed, × 5; 6, standard opened out, × 6; 7, wing petal, × 6; 8, keel petal, × 6; 9, gynoecium, × 6; 10, androecium, × 6; 11, flower bract, × 10.

long, 1,5 mm wide, reticulate, glabrous. **Seeds** 2 mm long, dull olive-green brown with scattered purple black blotches. Fig. 9.64.

Until very recently this rare species was only known from the vicinity of the Potberg Mountain where it is restricted to rocky places on the gentle lower slopes of the transition zone between Mountain Fynbos and Renosterveld (Fig. 9.65). Its rediscovery (*Stirton 11130*) near Hawston has increased its known range substantially. It is probable that *O. pungens* was more widespread in the intervening areas which are now under wheat cultivation. This species occupies the identical type of habitat as *O. lanceolatum* C.H. Stirton, but the two species are not known to be sympatric.

This distinctive but rarely collected species stands out from all other species of *Otholobium* by its sharply pointed leaves and pungent lower calyx tooth; hence the specific epithet *pungens*.

Specimens examined

-3419 (Caledon): 5 km from Hawston to Kleinmond (--CC), 14-1-1980, *Stirton 11130* (K, NBG).

-3420 (Bredasdorp); north of Potberg (--BC), 27-9-1962, *Acocks 22835* (PRE; K); 11-10-1967, *Taylor 7200* (PRE, K, STE); west base of the Potberg (-BC), 13-10-1940, *Pillans 9359* (BOL, K); De Hoop Nature Reserve (--BC), 17-9-1987, *Burgers 3322* (STE).

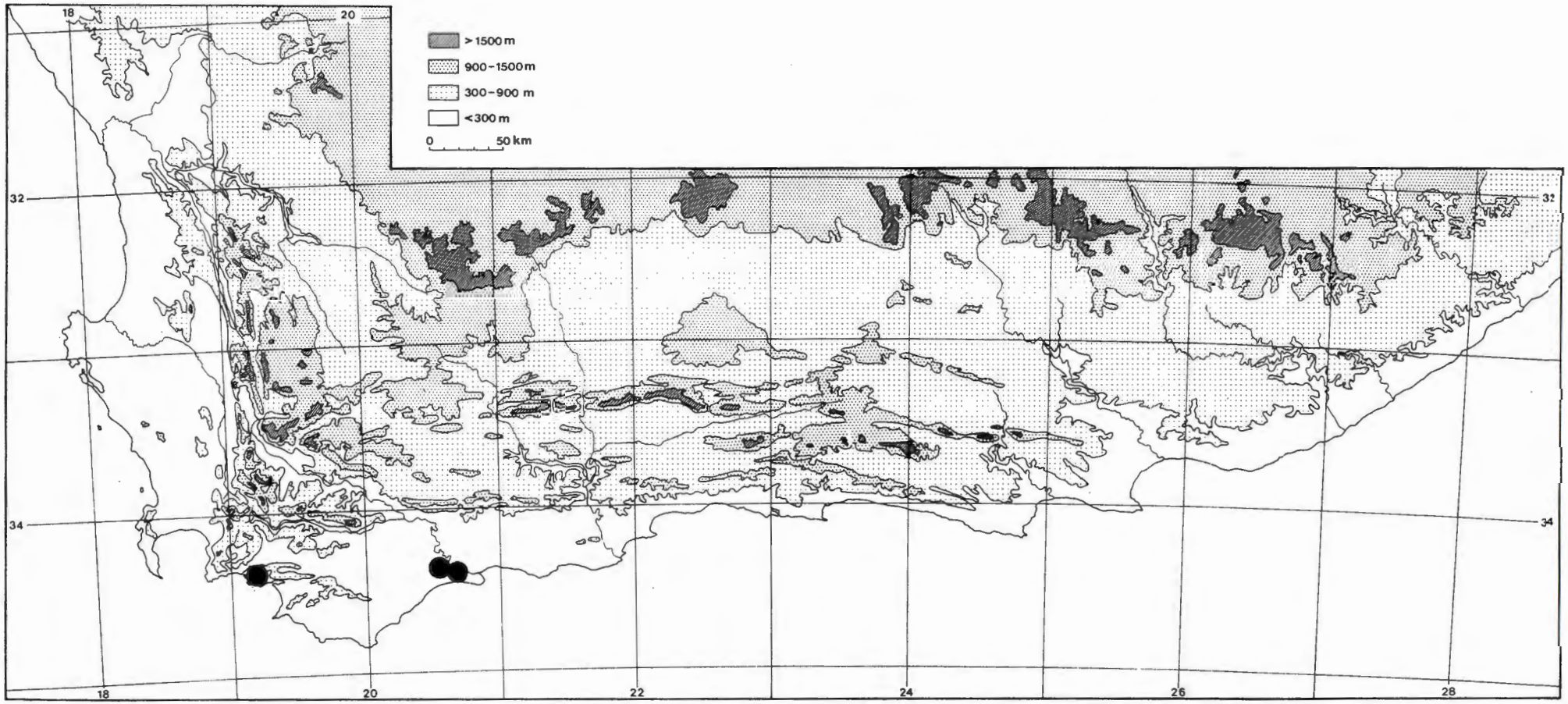


Fig. 9.65 Known distribution of *Otholobium pungens* C.H. Stirton in southern Africa.

29. Otholobium prodiens C.H. Stirton, *sp. nov., O. heterosepali affinis sed foliolis symmetricis, lobo carinalis calycis anguste triangulare, vexillo oblongo-elliptico et foliis crassis rigidis atroviridibus differt.*

Typus: Zuurberg Pass, 28-9-1984, *Stirton 10822* (GRA, holo; K, PRE, iso)

Frutex erectus usque 2,5 m altus, corona aperta, extremis ramorum tantum foliosus; rami juvenales subtiliter pubescentes, fusci. Folia digitatim trifoliolata, breviter petiolata. Foliola 10 -- 19 (30) mm longa, 4,5 -- 6,5 (9,0) mm lata, lateralibus et foliis annuis multo minoribus; obovata, apice emarginata, recurvato-mucronata, mucrone arcuata, base cuneata; ad angulum 45° disposita, glandulis utrinque manifestis, in vivo impressis lutescentesque, in sicco pallide aurantiacis; juvenalia in costa marginibusque utrinque pilosa, glabrescentia. Stipulae <1 mm longae, caducae. Inflorescentiae 2 -- 3, ad extremos ramulorum annuorum congestae; floribus pedicellatis in 1 -- 3 gregibus trifloris aggregatis, pedicellis 2 mm longis; grege omni a bractea multinerva ciliata truncata vel arcuata oblonga 1,0 -- 1,5 mm longa subtenta; pedunculo carente. Flores 8 -- 10 mm longi, albi vel eburnei, omnes a bractea 1,5 mm longa lanceolata pilosa subtenta. Lobi calyces inaequales, valde porcati 7 -- 8 mm longi, vexillares ultra tubum connati, dentibus quam tubo longioribus; dens carinalis quam alii longior, 5 mm, anguste triangularis; apice acuminati glandulis vix manifestes, parvis; sparsim atro pubescens. Vexillum 8,0 -- 8,5 mm longum, 4,5 -- 5,5 mm latum, oblongo-ellipticum superficie adaxiali leviter purpureo-suffusus, in lateribus pallide malvinium; macula alba nectaria paene ad apicem attingens. Alae 8 -- 9 mm longae, 2 mm latae, quam carina longiores, eburneae. Petala carinae 5 -- 7 mm longae, 2 mm latae. Androecium 6 -- 7 longum, pseudomonadelphum, fenestratum. Pistillum 5 -- 6 mm longum; ovarium 1 mm longum, glabrum vel pauci-pilosum, stipitatum ad apicem glandulosum, parte curvata 2 mm. Fructus seminaque ignoti.

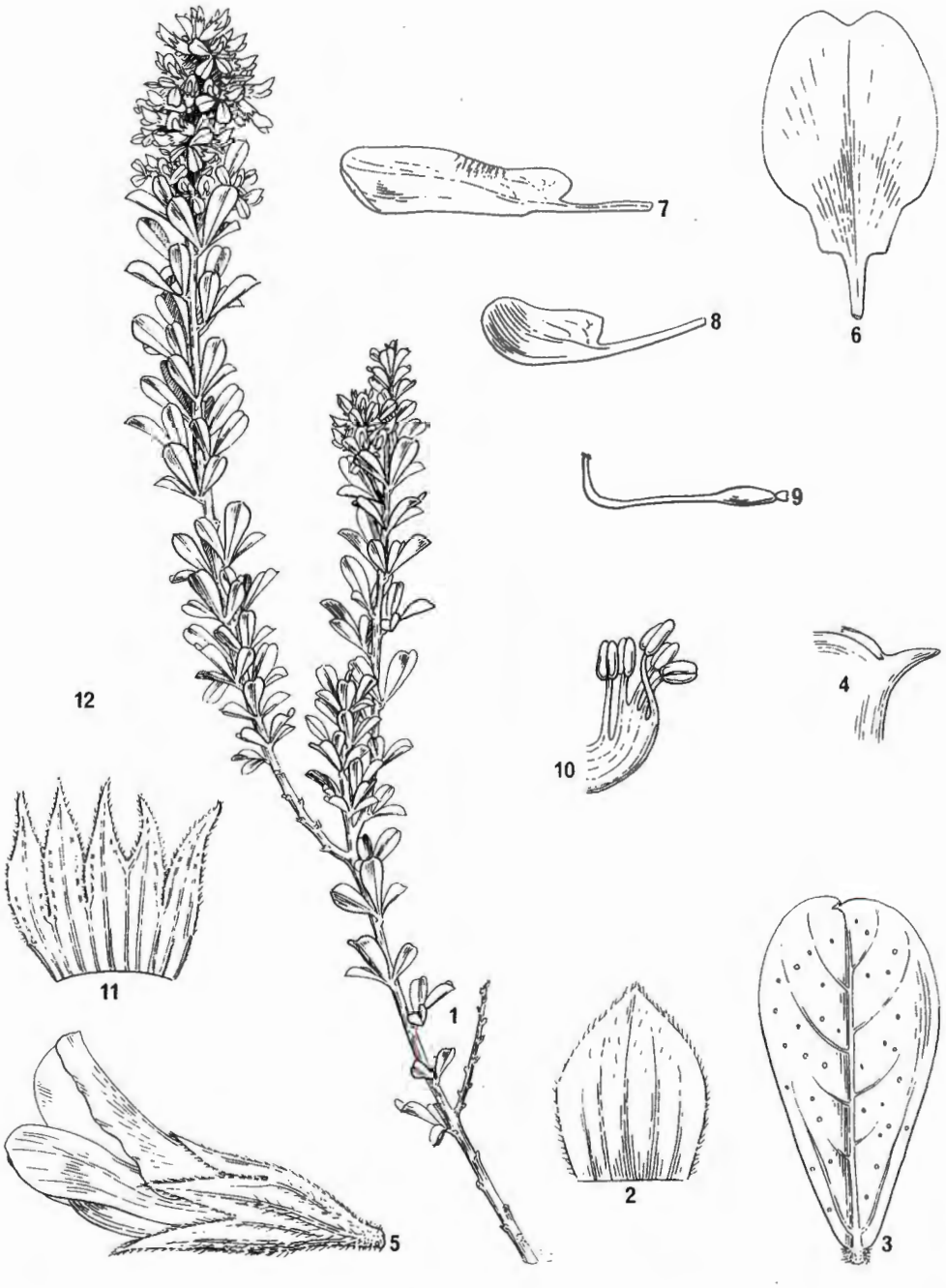


Fig. 9.66 *Otholobium prodiens*. 1, Flowering branch, $x^4/_5$; 2, Stipule, x24; 3, Terminal leaflet, inner face, x4; 4, Apex of terminal leaflet, x5; 5, Flower, x6; 6, Standard, x6; 7, Wing petal, x6; 8, Keel petal, x6; 10, upper part of filaments with half removed to show insertion, x6; 11, Calyx opened out, inner face, x6; 12, Flower bract, x8 (*Phillips 1109*, BOL).

Erect shrub up to 2,5 m tall, crown open, leafy at branch tips only; young shoots finely pubescent, dark. **Leaves** digitately trifoliolate, shortly petiolate. **Leaflets** 10 -- 19 (30) mm long, 4,5 -- 6,5 (9,0) mm wide, laterals and seasonal leaves much smaller; obovate, basally cuneate, apex emarginate, recurved mucronate, mucro arcuate, held at 45 degrees, glands on both surfaces but obscure below, impressed above yellowish when fresh, reddish black when dry; young leaves hairy on mid-rib and margins of both surfaces, glabrescent; petioles 2,0 -- 2,5 mm long. **Stipules** 1 -- 2 mm long, caducous. **Inflorescences** 2 -- 3, congested at the ends of seasonal shoots, comprised of 1 -- 3 triplets of pedicellate flowers; pedicels 2 mm long; each triplet subtended by a multinerved, ciliate, truncate or acute, oblong, 1,0 -- 1,5 mm long bract; peduncle absent. **Flowers** 8 -- 10 mm long, white or cream, each flower subtended by a persistent 1,5 mm long, lanceolate, hairy bract. **Calyx** teeth unequal, heavily ridged, 7 -- 8 mm long; vexillar lobes fused above the tube, teeth longer than the tube; carinal tooth longest, 5 mm long; narrowly triangular; apex acuminate; glands small, scarcely visible; sparsely black pubescent. **Standard** 8,0 -- 8,5 mm long, 4,5 -- 5,5 mm wide, claw 1,5 -- 2,0 mm long, oblong-elliptic, auriculate; front of standard lightly suffused with purple near the apex, pale mauve on the sides; a large white nectar patch extends almost to the apex; sides scarcely reflexed at anthesis. **Wing petals** 8 -- 9 mm long, 2 mm wide, claw 2 -- 3 mm long; longer than keel petals, cream to white, auriculate; sculpturing present, upper basal and upper left central, comprising from 10 -- 15 transcostal lamellae. **Keel petals** 5 - 7 mm long, 2 mm wide, claw 3 mm long, purple-tipped, apex rounded. **Androecium** 6 -- 7 mm long, pseudomonadelphous, fenestrate. **Pistil** 5 -- 6 mm long; ovary 1 mm long, glabrous or few haired, stalked, glandular at apex; style broadest at point of flexure, height of curvature 2 mm, penicillate. **Fruit** and seed unknown. Fig. 9.66.

Otholobium prodiens is widely distributed in the southern Cape stretching from the Langeberg Mountains in the west to as far east as Kingwilliamstown (Fig. 9.67). This species favours rocky outcrops with either a N or E facing slope. Plants occur either singly or in small groups. Flowering has been reported for most months of the year, but there is a distinct peak from July to November with most flowering taking place in October. It occurs between 200 -- 650 m altitude.

O. prodiens is characterized by a combination of its stiff leathery leaves, congested inflorescences in the upper axils of seasonal shoots, sparsely black-haired calyces and very large and distinctive white nectar patch on the standard. It has been confused in the past with *O. polyphyllum*, *O. carneum* and *O. heterosepalum*.

Specimens examined

-3227 (Stutterheim): Kingwilliamstown (--CD), 7-1881, *Tyson 1020* (SAM 5535, STE).

-3321 (Ladismith): Langberg above Welgevonden (--CC), 7-1913, *Muir 1113* (BOL, PRE); The Oaks, Gysmanshoek Pass (--CC), 16-9-1981, *Van Wyk* s.n. (PRE); Cloetes Pass, Mossel Bay (--DD), 22-8-1966, *Levyns 11578* (BOL); between farms Bonnievale and Perdekop (--DD), 14-9-1985, *Vlok 1140* (K, PRE, SAAS).

-3322 (Oudtshoorn): Ruitersbos (--CC), 9-12-1951, *Van Niekerk 65* (BOL, NBG, PRE); Hoopekraal, E. George (--DC), 6-11-1928, *Hutchinson 1299* (BOL, K, PRE); George (--CD), 19-8-1944, *Compton 15784* (BOL, NBG); *Alexander Prior* s.n. (K); 10-1916, *Phillips 1109* (BOL, SAAS); Saasveld (--DC), 8-1931, *Thorne* s.n. (SAM 51660); 12-12-1968, *von Breitenbach* s.n. (SAAS); near Kouna (--DD), 27-7-1985, *Vlok 1100* (GRA, K, NBG, PRE, SAAS).

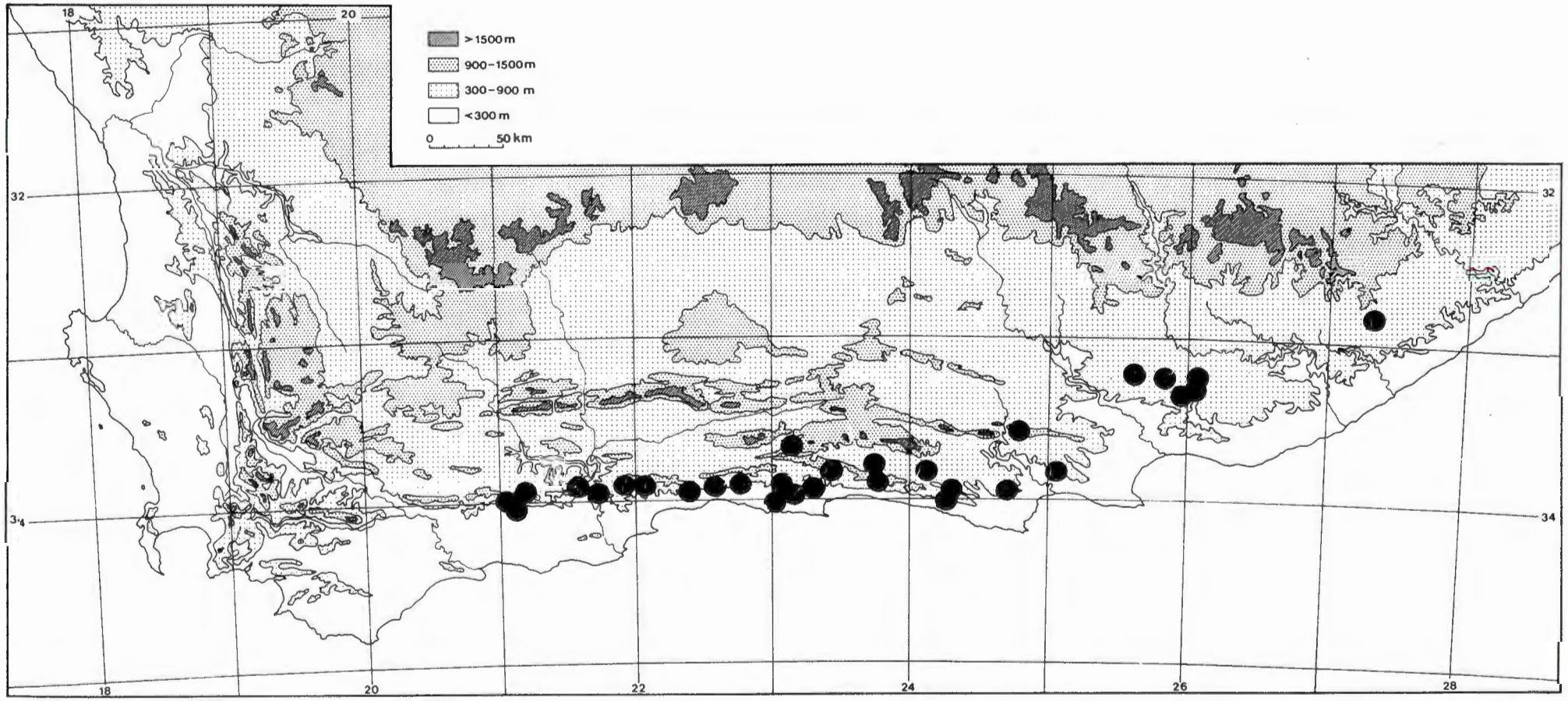


Fig. 9.67 Known distribution of *Otholobium prodiens* C.H. Stirton in southern Africa.

-3323 (Willowmore): Knysna hills (--CC), 10-1921, *Fourcade 1519* (BOL); Perdekop (--CC), 12-11-1949, *Barker 6019* (NGB); 3km W of De Vlugt, 26-10-1986, *Vlok 1682* (NU, SAAS); Knysna River (--CC), 10-12-1918, *Keet 2130* (BOL 278, PRE, STE); south foot of Prince Alfreds Pass (--CC), 10-1932, *Fourcade 4851* (BOL); Gonna Road (--CC), 7-7-1946, *Levyns 7844* (BOL); Keurbooms River Hill (--CD), 29-9-1943, *Fourcade 6126* (STE); Walletjies, off Long Kloof (--DC), 6-7-1974, *Bayliss 6575* (MO, NBG); Grootrivierpas (--DC), 6-8-1970, *Geldenhuys 100* (SAAS); Joubertina (--DD), 8-1942, *Esterhuysen 32236* (BOL).

-3324 (Steytlerville): Suuranys Pass, south slopes (--CC), 1-10-1984, *Stirton 10926* (K); Assegaibosch, Humansdorp (--CD), 12-11-1941, *Esterhuysen* s.n. (BOL); 9-1920, *Fourcade 857* (BOL, GRA, K, STE); 1-8-1912, *Rogers 2833* (GRA, SAM); 31-1-1920, *Schonland 3618* (GRA); Elandsberg Mountains, north of Patensie (--DB), 30-9-1984, *Stirton 10882* (K, PRE); near Humansdorp (--DC), 9-1922, *Fourcade 2330* (BOL, STE); The Heights, Humansdorp (--DC), *Fourcade 4225* (BOL).

-3325 (Port Elizabeth): Zuurberg Pass, Somerset East District (--BC), 20-10-1976, *Bayliss 7772* (MO); 13-8-1973, *Bayliss 5892* (NBG); Zuuberg (--BD), 10-1911, *Paterson 44* (GRA); 9-10-1985, *B-E. & M. Van Wyk 774* (RAU); Loerie Plantation (--CC), 10-1934, *Dix 134* (BOL); Longmore Forest Station (--CC), 13-11-1986, *Stirton & Zantovska 11602* (K, NBG).

-3326 (Grahamstown): Howiesons Poort (--AD), *Macowan 963, 1084* (BOL, MEL, PRE); Mountain Drive, Albany (--DC), 26-10-1922, *Britten 5244* (GRA).

-3421 (Riversdale): Oudebosch Crossing, Corente River Road (--AA), 16-9-1981, *Hugo 2770* (PRE, STE); Kleinberg (--AA), 8-1909, *Muir 484* (PRE).

-3423 (Knysna): Knysna (--AA), 6-5-1933, *Compton 4227* (BOL); 12-1918, *Keet 2716* (PRE); 4-1926, *Kapp 187* (STE); 7-7-1917, *Mitchell* s.n. (PRE); 1-1928, *Phillips 72* (BOL, PRE); Concordia (--AA), 26-2-1925, *Kapp 33* (L, PRE).

-3424 (Humansdorp): Clarkson (--AB), 9-1897, *Galpin 3961a* (GRA, PRE); Kromme River (--BA), 9-1920, *Fourcade 857* (PRE).

Without precise locality: 34 E of George, 6-11-1928, *Gillett 2156* (STE); Langfontein, Mossel Bay District, 26-7-1915, *Muir 2383* (BOL, PRE); loc. 91, between Swellendam and George, *Mund* s.n. (MEL 1542081); 10-8-1947, *Story 2751* (PRE).

30. Otholobium spicatum (L.) C.H. Stirton in S. Afr. J. Bot. 52:4 (1986).

Psoralea spicata L., Mant. alt. 264 (1771); Thunb., Fl. Cap. 307 (1823); E. Mey. in Linnaea 7: 166 (1832); E. Mey., Comm. 86 (1836); Eckl. & Zeyh., Enum. 229 (1836); Richter, Codex 739 (1840); Walp., Repert. 1: 657 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 154 (1862); Forbes in Bothalia 3: 134 (1930); Adamson & Salter, Fl. Cape Penins. 487 (1950). Type: "Habitat in Cap. b. spei campis", collector unknown. There are no specimens of this species in S. Three specimens exist in LINN (928.6 in Linnaeus's hand at the time; 928.7 and 928.8 both determined in L.f's hand and probably incorporated after 1771. *Thunberg 17584* in UPS belongs to this species.

P. spicata sensu Poiret in Lam., Method. 686 (1804) is *Otholobium striatum* (Thunb.) C. H. Stirton.

Erect virgate shrub up to 3,5 m tall. **Stems** 1 -- 2, pubescent, glabrescent when older, densely leafy and branched in upper half; lower branches abscise leaving naked yellowish-green stems below, mottled with many small white lenticels; young twigs cano-pubescent. **Leaves** digitately trifoliolate, petiolate, incurving to stem. **Leaflets** 20 -- 30 mm long, 7 -- 9 mm wide, laterals smaller and oblique, assymmetrical; obovate-oblong to oblong, nitid, mucronate, mucro arching, base cuneate, margin smooth, nigro-punctate when dry, clear and yellowish when fresh, sparingly glabrous, younger leaflets appressed sericeous, glabrescent; petiole 2 -- 4 mm long, shorter than stipules; petiolules < 1 mm long, sericeous. **Stipules** 4 -- 7 mm long, 1,5 -- 1,75 mm wide, longer than petioles, obliquely subulate, striate, membranous, glandular, appressed to stem, pubescent. **Inflorescences** pseudo-spicate, axillary in last three or four axils of short shoots, sessile, elongating in fruit, cylindrical, congested, 75 -- 150-flowered per inflorescence,

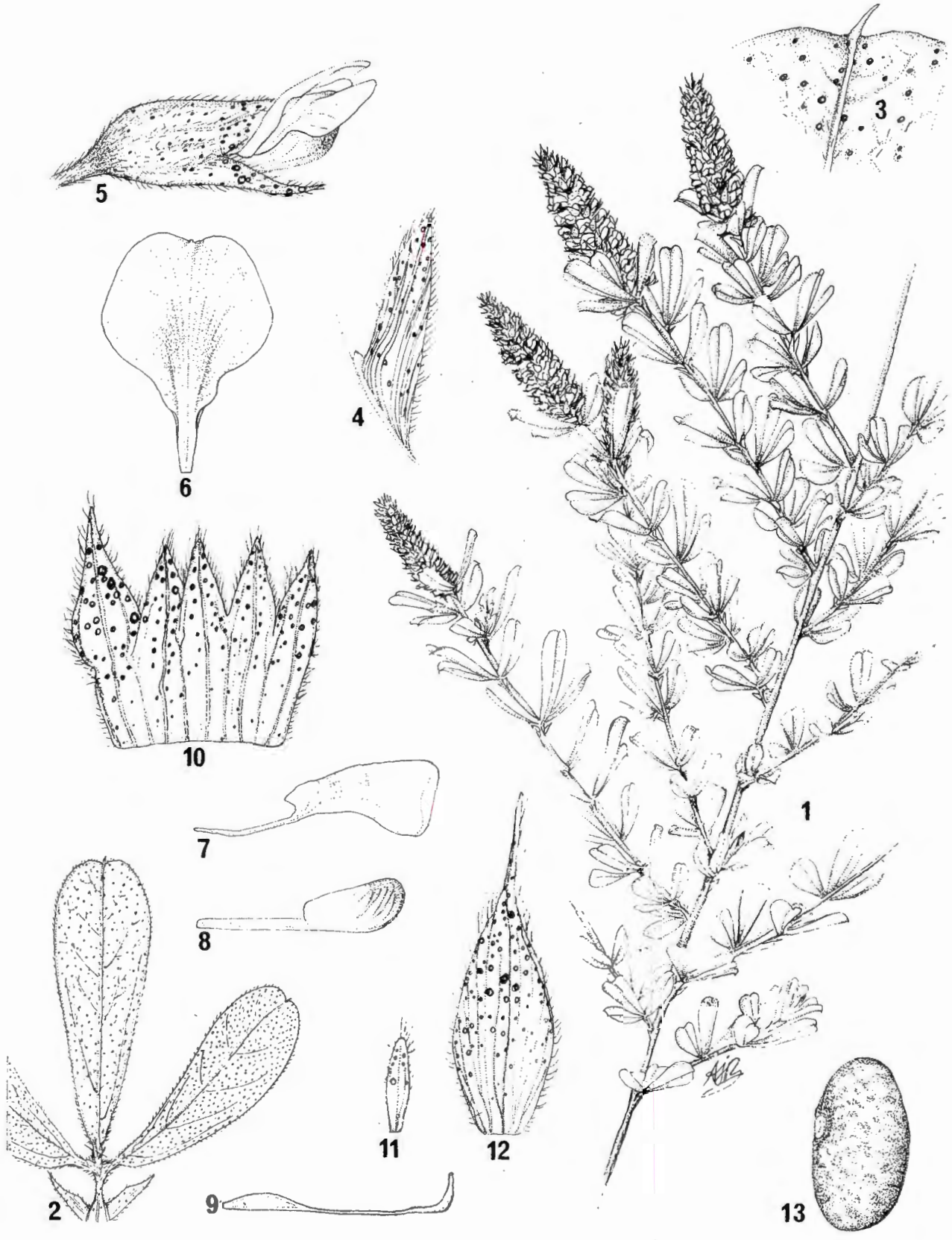


Fig. 9.68 *Otholobium spicatum*. 1, Upper portion of flowering stem, x$^1/_2$; 2, Digitately trifoliolate leaflet, terminal showing lower surface, laterals showing upper surfaces, x2; 3, Apex of terminal leaflet, x7; 4, Stipule, x7; 5, Flower, x7; 6, Standard, x6; 7, Wing petal, x6; 8, Keel petal, x6; 9, Pistil, x8, 10, Calyx opened out, inner face, x8; 11, Flower bract, x9; 12, Triplet bract, x9; 13, Seeds, x10 (1-12, *Parker 3862*; 13, *Stirton 8363*).

each triplet of flowers subtended by a small membranous, 3 mm long, 1,5 mm wide, pubescent, glandular bract. **Flowers** 8 -- 9 mm long, slate lilac; held erect at 30° from axis, bract lanceolate, ciliate, minute. **Calyx lobes** equal, 4 -- 6 mm long, more or less equal to the tube; 2 -- 3 mm long vexillar teeth fused for up to half their length above the tube; carinal tooth slightly wider, 1,5 -- 1,8 mm wide; softly pubescent with larger glands on the teeth and fewer smaller scattered glands on the tube; shorter than androecium. **Standard** 4 -- 7 mm long, 4,5 -- 5,0 mm wide, scarcely reflexed, elliptic, auriculate; claw prominent, 3 mm long, apex emarginate, glabrous. **Wing petals** 7 mm long, 2,0 -- 2,5 mm wide, claw 3 mm long; exceeding keel petals, pale mauve; sculpturing upper basal and upper left central, comprised of up to 12 reclining transcostal lamellae. **Keel petals** 5 -- 6 mm long, 1,5 -- 2,0 mm wide, claw 3,0 -- 3,5 mm long, 2 mm wide, apex rounded. **Androecium** 5 -- 6 mm long, tenth stamen fused along lower third of the adaxially split sheath, anthers 0,2 -- 0,3 mm long, equal. **Pistil** 6 mm long; ovary 1,5 -- 2,0 mm long, height of curvature 1,25 mm high; glabrous with few glands. **Fruit** papery, 4 mm long, 2 mm wide, reticulate, glabrous. **Seeds** 2,5 -- 3,5 mm long, 1,5 -- 2,0 mm wide, covered with brownish-purple mottles on a khaki green background. Fig. 9.68 & 9.69.

Otholobium spicatum is a common gregarious plant where it occurs sometimes forming extensive dense stands. It tends to favour disturbed sites and is found along dry gravelly ridges and shale slopes in coastal fynbos (Fig. 9.70). It has become quite common along roadsides. Flowering takes place between October and December, with a peak in November. The species occurs between 30 -- 500 m altitude.

Specimens examined

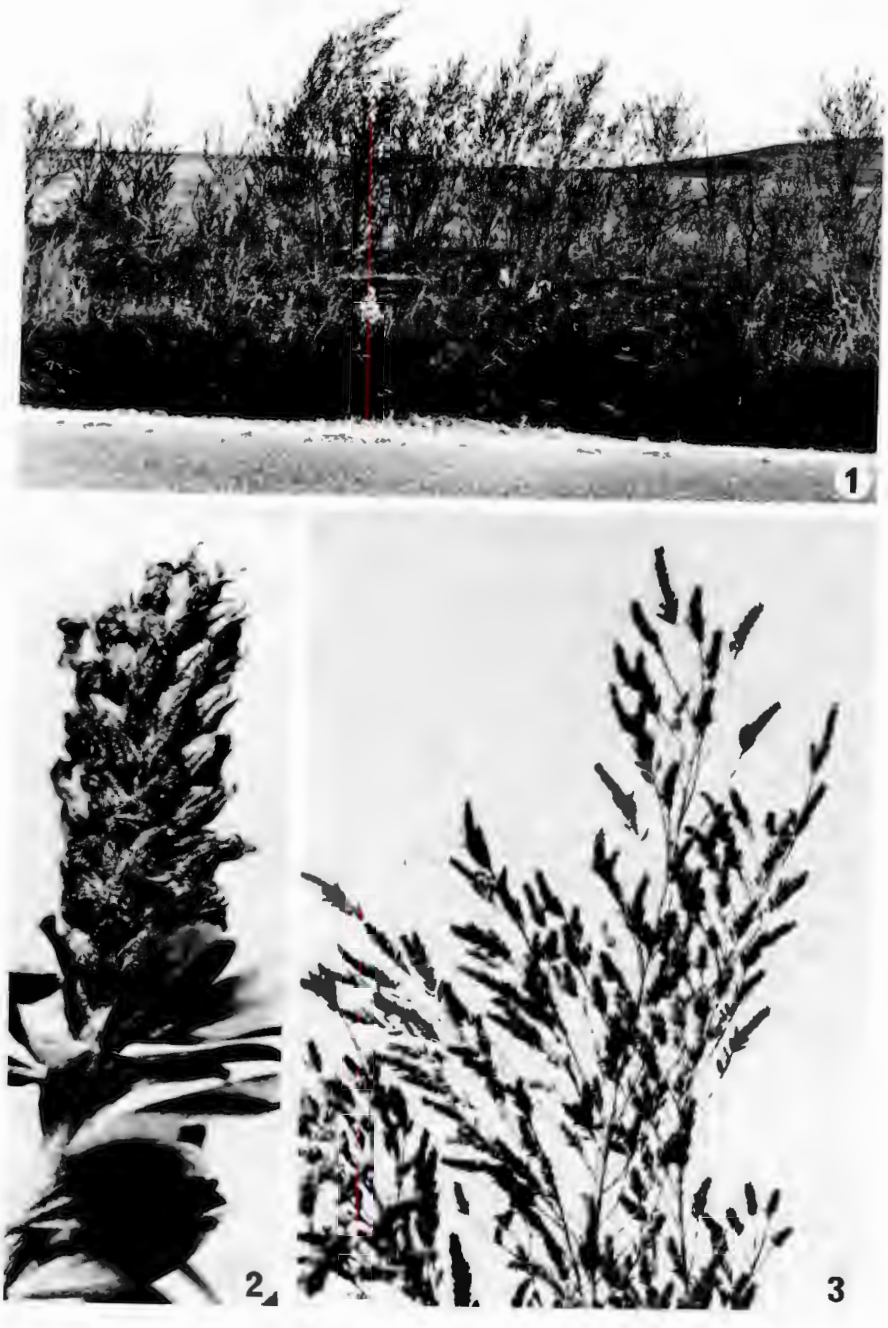


Fig. 9.69 *Otholobium spicatum*. 1, Roadside population near Swellendam showing dense stand and typical erect habit; 2, Infructescence; 3, Part of and erect branching stem. Notice the large number of infructescences, each containing 50 or more seeds. (All *Stirton 10254*).

-3318 (Cape Town): Kirstenbosch (--CD), 10-11-1927, *Smith 4848* (PRE); 20-10-1937, *Thomas* s.n. (NBG); Hillcrest (--CD), 10-11-1927, *Smith 4845* (PRE); Cape Flats near Cape Town (--DC), 10-1892, *Bolus 1429* (G, K, SAM, STE, W).

-3319 (Worcester): Fransch Hoek Pass (--CC), 4-11-1965, *Esterhuysen 31364* (BOL); 28-10-1913, *Phillips* s.n. (SAM); near Pupasvallei (--DC); *Ecklon* s.n. (K, W); Bergendal Farm, lower foothills of Langberg and Klaasvoogds (--DD), 1-11-1983, *Rourke 1813* (NBG).

-3320 (Montagu): between Swellendam and Montagu (--CD), 4-12-1960, *Gentry 18968* (MO, PRE, US); Tradouw Pass (--DC), 10-1925, *Barnard* s.n. (SAM); Grootvaderbos (--DD), 7-12-1981, *Stirton 10213* (K, PRE); *Zeyher* s.n. (SAM).

-3418 (Simonstown): Wynberg Hill (--AB), 11-1913, *Bolus* s.n. (PRE); 10-1938, *Malan* s.n. (STE); 23-1-1929, *Gillett 3317* (STE); near Protea (--AB), 11-1980, *Bolus 7101* (BOL, K); Somerset West (--BB), 24-10-1943, *Parker 3862* (K, NBG); Sir Lowrys Pass (--BB), 28-11-1980, *Stirton 8363* (K, PRE).

-3419 (Caledon); Caledon (--AB); 4-1902, *Southey 5029* (PRE); 9-12-1981, *Stirton 10252* (K, PRE); by the Zoetemelks River (--BA), 11-11-1814, *Burchell 6608* (K); Ganskraal Farm, on Greyton road near Riviersonderend Mountains (--BB), 11-8-1980, *Schonken 417* (PRE).

-3420 (Bredasdorp): Bontebok National Park (--AB), 7-11-1962, *Acocks 22912* (K, PRE); Swellendam (--AB), *Marloth 3548* (STE); *Zeyher* s.n. (SAM 49252); Buffelsjagdam (--BA), 10-1975, *van der Merwe 2686* (PRE); 28-10-1894, *Penther 2578* (W); Zuurbraak (--BA), 24-10-1894, *Schlechter 1515* (PRE, Z), *5702* (K, PRE, U, Z); 27-10-

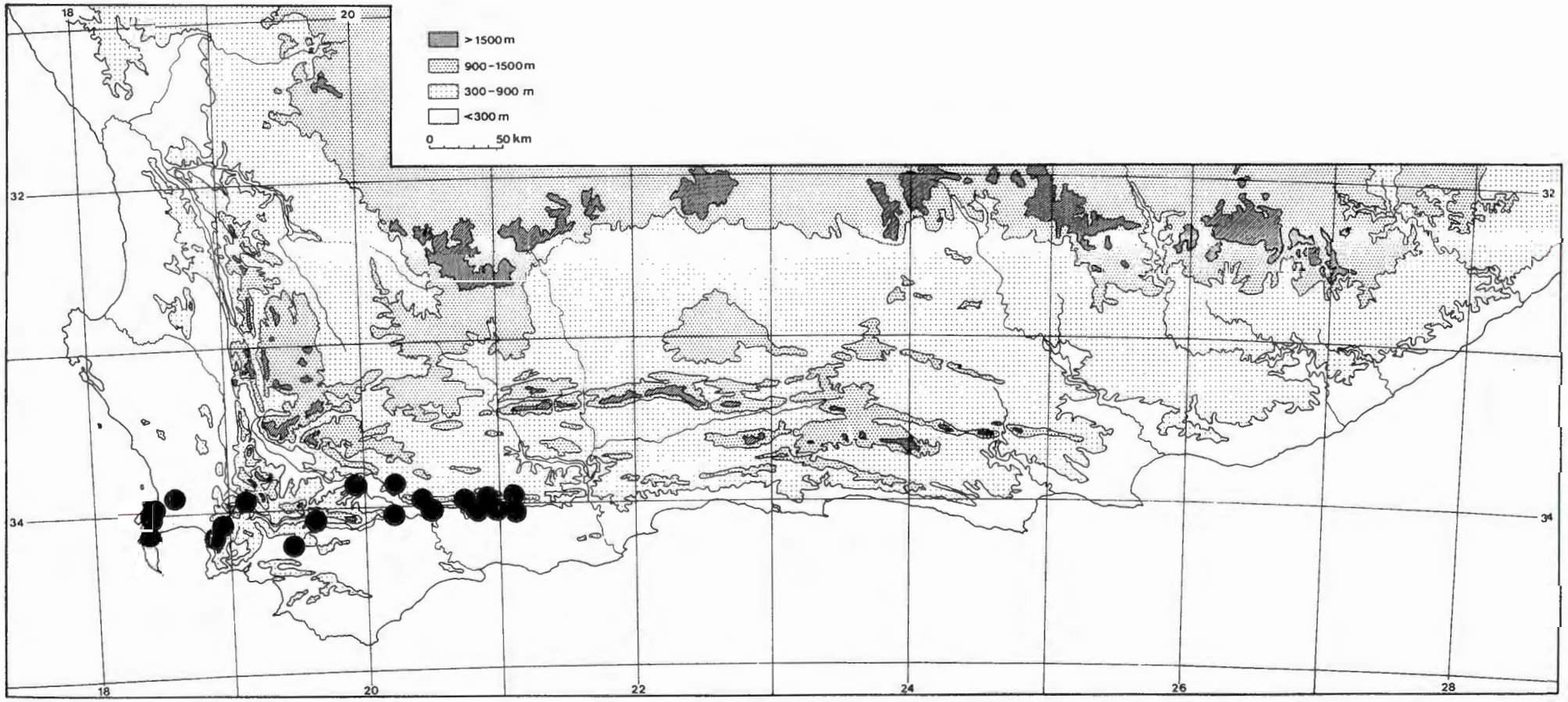


Fig. 9.70 Known distribution of *Otholobium spicatum* (L.) C.H. Stirton in southern Africa.

1894, *Penther 2495* (W); 15 km from Swellendam to Heidelberg (--BA), 9-12-1981, *Stirton 10254* (K, PRE); between Swellendam and Riversdale (--BB), 3-12-1952, *Godfrey 1308* (PRE, US); 24 km from Heidelberg to Zuurbraak (--BB), 10-9-1983, *Grobbelaar 2789* (PRE); 25 km from Swellendam to Heidelberg (--BB), 9-12-1981, *Stirton 10255* (K, PRE).

-3421 (Riversdale): Corrente River Farm (--AA), 11-1908, *Muir 83* (BOL, PRE); 5 km from Riversdale to Ladismith (--AA), 10-12-1981, *Stirton 10274* (K, PRE); 3 km from Heidelberg to Riversdale (--AA), 9-12-1981, *Stirton 10256* (K, PRE).

Without precise locality: *Bowie* s.n. (K); *Burmann* s.n. (G); *Drge* s.n. (PRE); *Ecklon & Zeyher* s.n. (G, OXF, TCD); *Forster* s.n. (K); between Zuurbraak and turnoff to Strawberry Hill, 21-10-1986, *Goldblatt 7976* (MO, NBG).

31. Otholobium mundianum (Eckl. & Zeyh.) C. H. Stirton in S. Afr. J. Bot. 52: 3 (1986).

Psoralea mundiana Eckl. & Zeyh., Enum. 228 (1836); Walp. in Linnaea 1: 656 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 148 (1862); Forbes in Bothalia 3: 122 (1930). Lectotype: " Prope Gorreehoogde, Swellendam", *Mund 84* (K, lecto; S, SAM 49206, iso).

P. spathulata E. Mey., Comm. 85 (1836); Walp., Repert. 1: 656 (1842). Lectotype: "In montosis rupestribus Dutoitskloof", *Drège* s.n. (K, lecto; G, GBH, W, iso). There is a second sheet in G which is part of a mixed gathering. The specimen is *O. nitens* C. H. Stirton.

P. decumbens Willd. (1802) non Ait. (1789).

Erect, densely leafy, much-branched shrub to 1 m high. **Stems** 1 -- few, pustulate, pubescent. **Leaves** digitately trifoliolate, petiolate, stipulate, erect. **Leaflets** (15) 20 -- 30 (35) mm long, (7) 8 -- 11 mm wide, subequal, laterals somewhat arcuate, assymetrical, about 2/3 length of terminal leaflet; yellowish green, obovate to narrowly obovate, recurved mucronate, thin, base acute, margin undulate, prominently pellucid-dotted, drying orange, crateriform; young leaflets hairy with ciliate margins, the older leaves glabrescent; petiole 3 -- 5 mm long, persisting after leaf abscission; petiolules 1 mm long. **Stipules** 3 -- 6 mm long, 2,5 -- 3,0 mm wide, shorter than petioles, obliquely broadly ovate, pubescent, striate, rigidly scarious. **Inflorescences** axillary, in axils of upper nodes of densely leafy seasonal shoots, scarcely pedunculate, pedicellate; comprised of 3 -- 4 triplets of flowers, each triplet subtended by an ovate bract, 3 -- 4 mm long, 1,5 -- 4,0 mm wide, striate, irregularly toothed to apiculate, ciliate, broadly ovate to oblong. **Flowers** 9

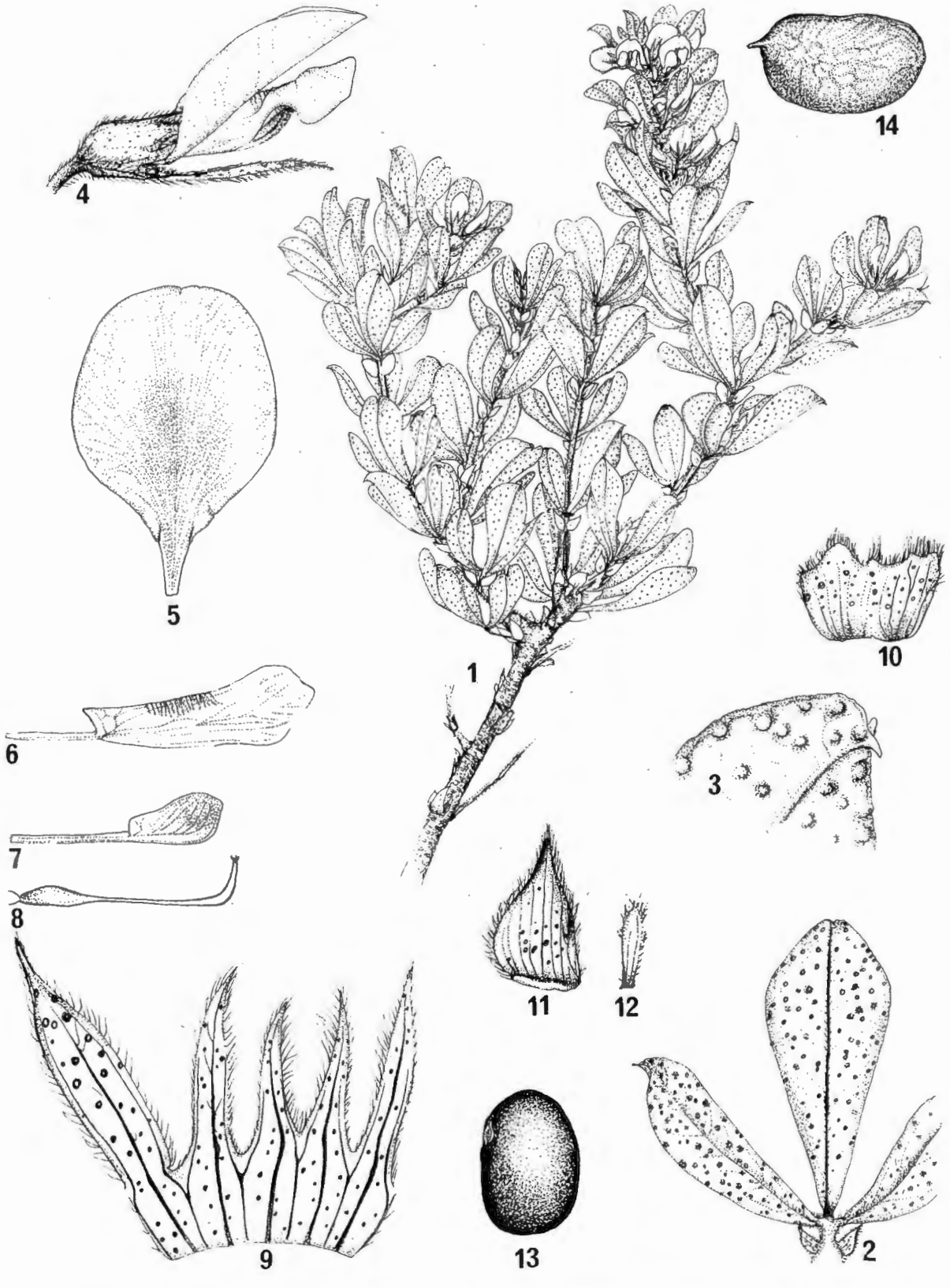


Fig. 9.71 *Otholobium mundianum*. 1, Flowering branches, x1; 2, Digitately trifoliolate leaflet, terminal showing lower surface, and laterals upper surface, x3; 3, Apex of terminal leaflet, x6; 4, Side view of flower, 5,5; 5, Standard, x5; 6, Wing petal, x6; 7, Keel petal, x6; 8, Pistil, x7; 9, Calyx opened out, inner face, x8; 10, Triplet bract, x7; 11, Stipule, x7; 12, Small bract covered by stipule, x7; 13, Seed, x6; 14, Fruit, x6 (1-12, *Stokoe 1052*; 13-14, *Mund* s.n., K).

ciliate, single-nerved lanceolate bract; pedicel 3,0 -- 3,5 mm long. **Calyx lobes** subequal, 6 -- 8 mm long, much longer than the 2 mm deep tube; carinal tooth, 6 mm long, 1,5 mm wide, broader and longer than the other four lanceolate teeth, vexillar teeth fused 1 mm above the tube; villous, glandular all over, larger on the carinal tooth; accrescent. **Standard** 9 mm long, 5 mm wide, elliptic, auriculate, claw 2 mm long, apex rounded. **Wing petals** 9 mm long, 3,0 -- 3,5 mm wide, auriculate, claw 2 -- 3 mm long; sculpturing present, upper basal and upper central, comprised of 10 -- 20 transcostal lamellae. **Keel petals** shorter than the wing petals, 6 mm long, 1,8 -- 2,0 mm wide, claw 3 mm long. **Androecium** 6 mm long, fenestrate, sheath split adaxially, vexillar stamen fused to edge of sheath in lower third. **Pistil** 5,0 -- 5,5 mm long; ovary 1,5 mm long, stipitate, glandular; style broadest at point of flexure; height of curvature 1,5 mm long, stigma penicillate. **Fruit** 5 mm long, 3 -- 4 mm wide, papery, thin, brittle, broadly reticulate, glabrous. **Seeds** 3,5 mm long, 2,5 mm long, reddish-black; hilum round. Fig. 9.71.

Otholobium mundianum occurs among rocky outcrops in Mesic Mountain Fynbos between 1000 -- 1500 m altitude (Fig. 9.72). Flowering takes place from late November to late January.

O. mundianum is most closely related to *O. nitens*. It differs from *O. nitens* in its size, reddish orange colour of the leaves when dry, paucity of foliar glands on the leaves, and white haired calyces. See that species for a key separating them.

Specimens examined

-3318 (Cape Town): Simonsberg (--DD), 6-12-1942, *Bond 1550* (BOL, NBG).

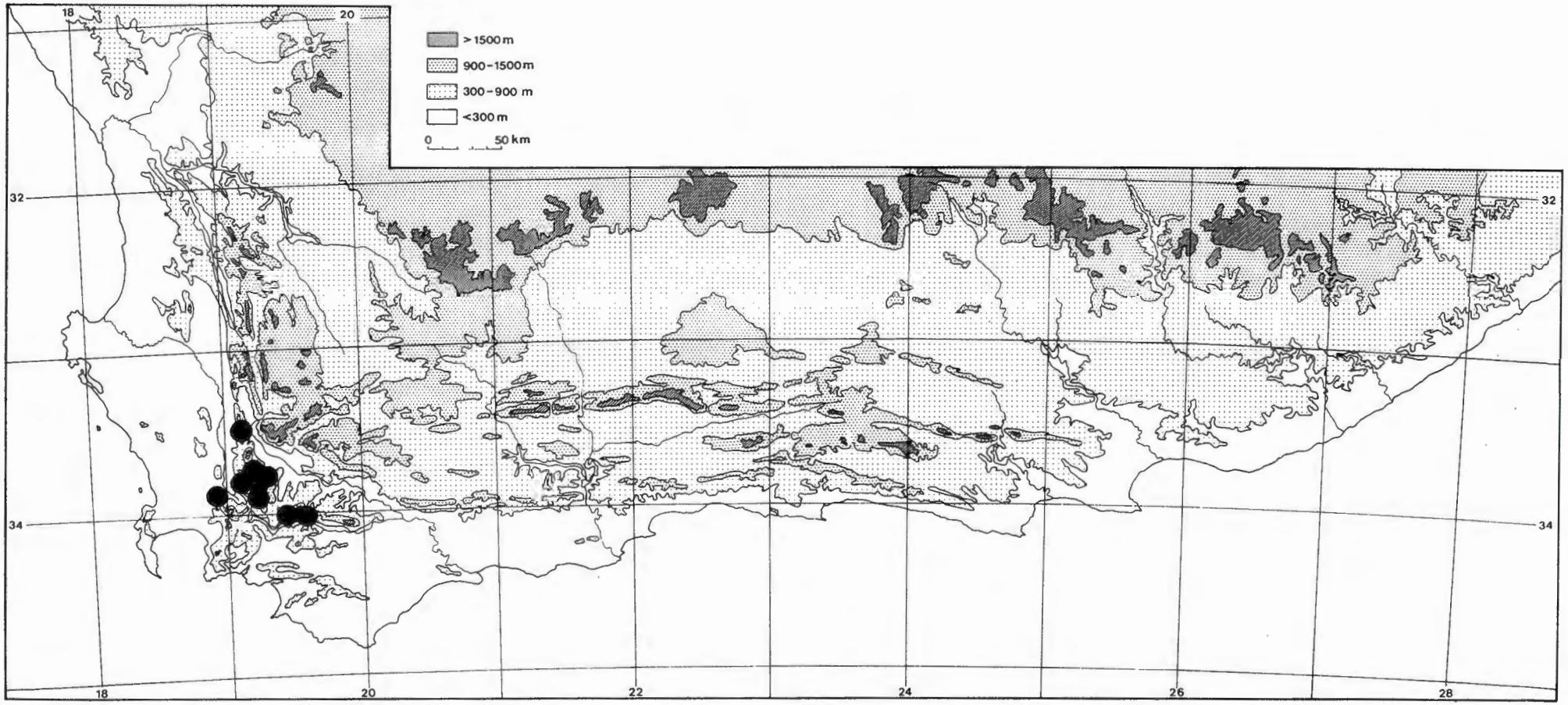


Fig. 9.72 Known distribution of *Otholobium mundianum* (Eckl. & Zeyh.) C.H. Stirton in southern Africa.

-3319 Worcester): Observation Point, Bainskloof Mountains (--CA), 23-1-1982, *Esterhuysen 35743* (BOL); Du Toits Kloof (--CA), *Drège* s.n. (G, GBH, K, PRE); Du Toits Kloof Peak (--CA), 27-12-1949, *Esterhuysen 16648* (BOL); Haelhoek Sneeukop (--CC), 21-12-1952, *Esterhuysen 20873* (BOL); Felixberg (--CC), 6-12-1964, *Esterhuysen 30871* (BOL); Perdekop (--CC), 1-4-1988, *Bean 2005* (BOL); Wemmershoek Peak (--CC), 12-1944, *Lewis 896* (NBG, PRE, SAM); 1-1921, *Andreae 684* (STE); Franschhoek Mountains (--CC), 1-1918, *Marloth 8143* (BOL, PRE); 15-1-1987, *Bean* s.n. (K, BOL), 28-11-1946, *Dickson* s.n. (NBG); 23-12-1895, *Bolus 8620* (BOL, K, NBG).

-3419 (Caledon): between Genadendal and Olifantsberg (--AB), 2-1-1965, *Esterhuysen 30916* (BOL); Baviaanskloof, near Genadendaal (--BA), 16-2-1815, *Burchell 7766* (K).

Without precise locality: Gorreehoogde, *Mund* s.n. (MEL 1541979).

32. Otholobium lucens C.H. Stirton, *sp. nov., O. caffri affinis sed inflorescentiis paucifloris, foliis glandulis nitentibus protuberantibus crateriformibus utrinque aequaliter dispositis, foliolis abrupte recurvatis mucronatis aequalibus, et bracteis florium filiformibus differt.*

Typus: 3322 (Oudtshoorn): Cango Valley, Rus-en-Vrede, Oudtshoorn district (--AD), 11-11-1986, *Stirton, Vlok & Zantovska 11561* (NBG, holo; BOL, C, G, K, L, M, MO, NSW, PRE, S, iso).

Frutex regenerans usque 60 cm altus. Caules multi, prope basin ramosi, fissi, luteo-brunnei vel atri, saponem siccatum simulans; ramuli annui foliosi; planta cetera aphylla; ramuli pubescentes glanduli prominentes nitentes obtecti. Folia digitatim trifoliolata, petiolata et in fructicibus vetustioribus floribus carentibus multo minora, angustiora, duriora. Foliola subaequalia symmetrica; terminale 13 -- 16 mm longum, 4,0 -- 6,5 mm latum obovatum; laterales minora, foliola ex caule orientia maiora, 20 -- 30 cm longa, 8 -- 13 mm lata; apice obtusa, basi cuneata manifeste glandulis prominentibus crateriformibus nitentibus in secco aurantiacis amplitudine variabilibus utrinque aequaliter dispositis sed inferne solum prominentibus obtecta; glabra; petiolus 1 -- 2 (3) mm longus; petiolulus 1 mm longus. Stipulae 2 -- 3 mm longae, subulatae appressae. Inflorescentiae in ramulis brevibus annuis axillares, pedunculo 3 -- 5 mm longo; flores brevipedicellati in gregibus, 1 -- 2 trifloris aggregates, grege omni a bractea singulari oblonga, 1,0 -- 1,5 mm longa multidentata apice obtusa subtenta. Flores 9 mm longi, pallide malvini, corolla quam calyce duplo maiore. Lobi calycis aequales, 4 -- 5 mm longi; tubus 3,5 mm longus; dentes triangulares, apice acuti, quam tubus multo breviores, extus ubique glandulosi, atro-pubescentes; costae prominentes. Vexillum 9 -- 10 mm longum, 7 -- 8 mm latum, album sed maculo nectario viridiornatum, apice emarginatum. Alae 8,5 -- 10,0 mm longae, 2,5 -- 3,0 mm latae. Petala carinae 7 -- 8 mm longa, 2,0 -- 3,0 mm lata. Androecium 7 mm longum, pseudomonadel-

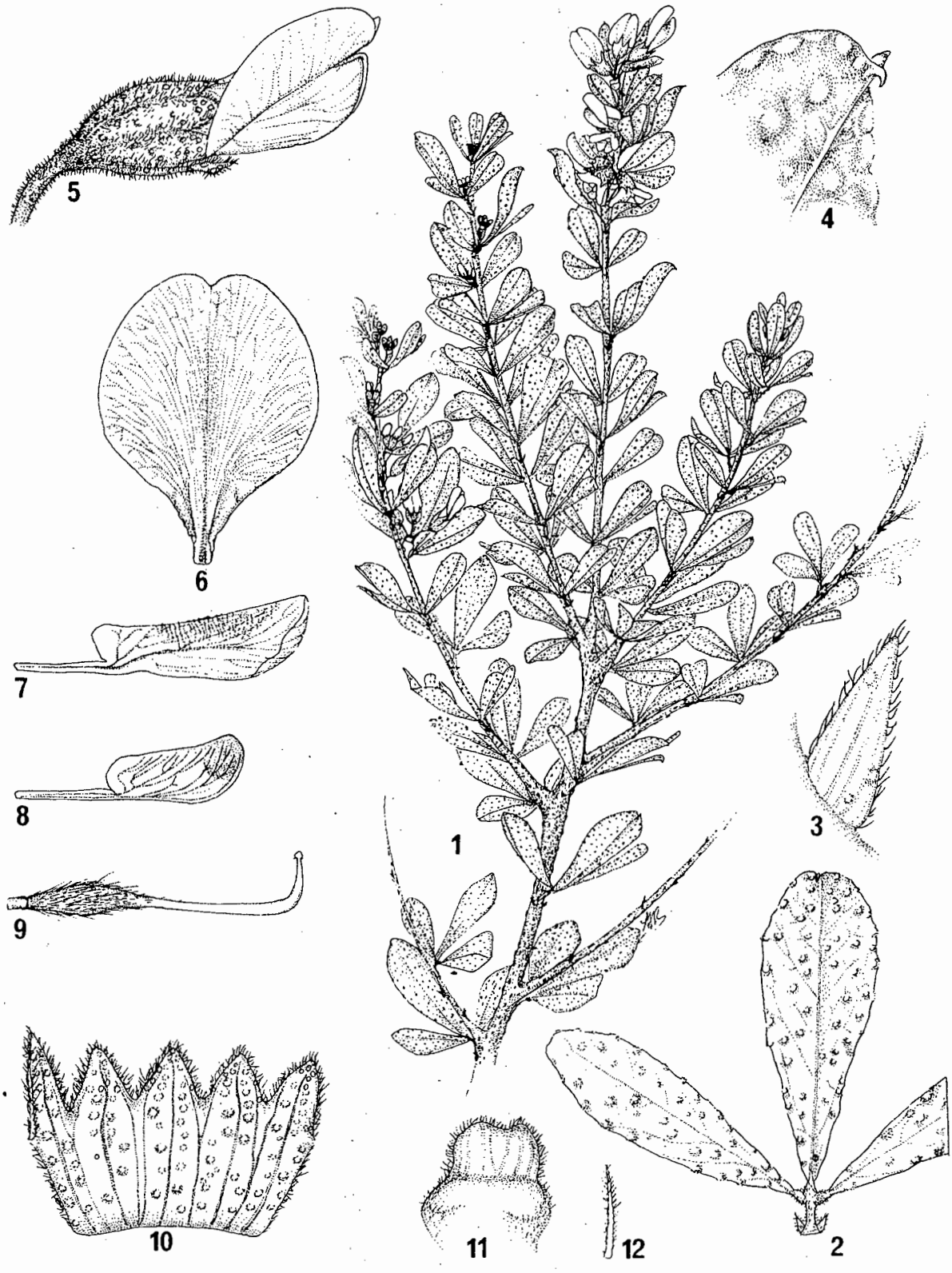


Fig. 9.73 *Otholobium lucens*. 1, Flowering shoots, x1; 2, Digitately trifoliolate leaflet, terminal showing lower surface, laterals upper surfaces, x3,5; 3, Stipule, x20; 4, Apex of terminal leaflet, x10; 5, Side view of flower, x5; 6, Standard, x5,5; 7, Wing petal, x5,5; 8, Keel petal, x5,5; 9, Pistil, x6,5; 10, Calyx opened out, inner face, x8; 11, Triplet bract, x10; 12, Flower bract, x13 (*Marloth 12131*).

phum. Pistillum 7 mm longum; ovarium 2,5 mm longum, hirsutum, gynophoro 1 mm longo, parte curvata 1,5 -- 1,8 mm alta, entase ante partem flexuosam magis evoluto. Fructus seminaque ignoti.

Resprouting shrub to 60 cm tall. **Stems** many, branching near the base, cracked, yellowish-brown to black, scurfy; seasonal shoots leafy, rest of plant without leaves, twigs pubescent with prominent raised shiny glands. **Leaves** digitately trifoliolate, petiolate; leaves on older non-flowering shrubs much smaller, narrower and harder. **Leaflets** symmetrical; terminal leaflet 13 -- 16 mm long, 4,0 -- 6,5 mm wide, obovate; laterals slightly smaller; stem leaflets larger, 20 -- 30 cm long, 8 -- 13 mm wide; apex obtuse, base cuneate; prominently covered in variously sized, raised, crateriform, shiny orange glands (in dried state), about the same number and pattern on both surfaces, raised on lower, flush on upper; glabrous; petiole 2 -- 3 mm long, petiolule 1 mm long. **Stipules** 2 -- 3 mm long, subulate, appressed. **Inflorescences** axillary on short seasonal shoots, peduncle 3 -- 5 mm long, comprised of 1 -- 2 triplets of shortly pedicellate flowers, each triplet subtended by a single 1,0 -- 1,5 mm long, oblong, multi-toothed, flabellate, 1 -- 2 mm long bract with blunt apex. **Flowers** 9 mm long, pale mauve. **Calyx** half the length of the corolla; lobes equal, 4 -- 5 mm long, tube 3,5 mm long; teeth triangular, apex acute, much shorter than tube; ribs prominent, glandular over entire surface, black pubescent. **Standard** 9 -- 10 mm long, 7 -- 8 mm wide, claw < 1 mm long; elliptic, white with green basal nectar patch, apex emarginate, auricle scarcely developed. **Wing petals** 8,5 -- 10,0 mm long, 2,5 - 3,0 mm wide, claw 2,5 -- 3,0 mm long, auriculate; sculpturing present, upper basal and central, comprised of 25 -- 50 inter and intracostal interlocking lamellae; fused to keel petals near the auricles. **Keel petals** 7 -- 8 mm long, 2,0 -- 3,0 mm wide, claw 3,0 -- 3,5 mm long. **Androecium** 7 mm long, pseudomonadelphous, vexillar stamen

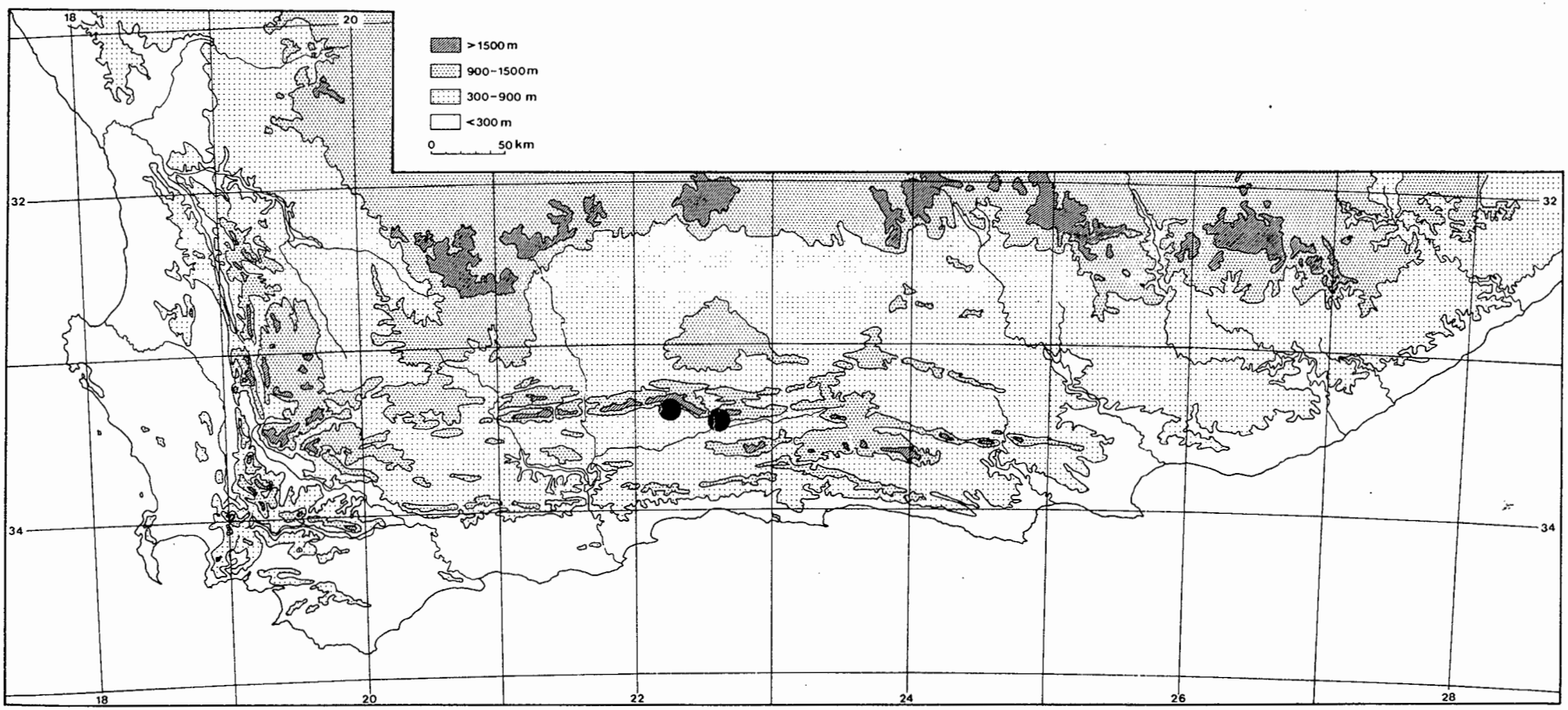


Fig. 9.74 Known distribution of *Otholobium lucens* C.H. Stirton in southern Africa.

has an undulating surface. **Pistil** 7 mm long, ovary 2,5 mm long, hirsute, gynophore 1 mm long; height of curvature 1,5 -- 1,8 mm, entasis best developed before point of flexure, stigma capitate. **Fruits** and seeds unknown. Fig. 9.73.

Otholobium lucens is a rare species confined to the foothills of the Groot Swartberg Mountains in the Ladismith area of the Cape Province (Fig. 9.74). This strong resprouter frequents the transition between Acocks's Mountain Renosterveld (VT. 43) and False Macchia (VT. 70). Flowering takes place from July to November. It occurs at 600 -- 650 m altitude.

Specimens examined:

-3322 (Oudtshoorn): Teringbos, Oudtshoorn (--AC), 6-1925, *Marloth 12131* (PRE); near Melville Dam (--AC), 10-1951, *Zinn* s.n. (SAM 65960); Rus-en-Vrede, Oudtshoorn (-AD), 1907, *Taylor 323* (BOL, GRA); 11-11-1986, *Stirton, Vlok & Zantovska 11561* (K, NBG, PRE).

33. Otholobium nitens C.H. Stirton *sp. nov., O. mundiani affinis sed foliis congestis atroviridibus nitidis et glandulis internis pellucidis insigne numerosis magnitudo variosis, dente carinali calycis lato atropiloso, alis quam carina duplo longioribus differt.*

Typus: 3419 (Caledon): Cape, between Krom Rivier Peak and Krom Rivier Dome, Krom Rivier Kloof (--AA), 10-10-1963, *Esterhuysen 30375* (BOL, holo; K, MO, NBG, iso).

Frutex erectus dense ramosus aliquantum cylindricus usque 1,5 mm altus. Caules 1 - multi, pubescentes, nitidi ubi villosi, internodis brevibus. Folia digitatem trifoliolata, petiolata, ascendentia, in extremis ramulorum brevium annuorum aggregatis. Foliola 20 -- 30 (35) mm longa, 3,0 -- 3,5 (11,0) mm lata; lateralia arcuata, asymmetrica, longtudine $^{2/3}$ longitudine folioli terminalis; auguste obovata vel obovata, recurvato-mucronata, basi cuneata, margine subtiliter crenata; pagina nitida dense glandulosa glandulis impressis vel in superficie glebosa solum manifestis, pellucidis, in sicco atreis vel rubro-brunneis; glabra, juventute in costa marginibusque valde appresse sericea; petiolus 3,5 -- 4,0 mm longus, post casum folii persistens; petiolulus 1 mm longus. Stipulae 3 -- 5 mm longae 3 mm latae quam petioli longiores, oblique ovato-lanceolatae vel triangulares, striatae, membranosae, glandulosae, aliquantum patentes, pubescentes. Inflorescentiae ex axilibus ramulis brevibus orientibus, pedunculatae, pedicellatae; pedunculus 5 -- 7 mm longus; gregem solitariam trifloram et bractea ovata 5 mm longa, 4 mm lata atropilosa glandulosa subtentam continentes. Flores 11 -- 13 mm longi, caeruleo-malvin. Lobi calycis inaequales, 10 -- 12 mm longi, tubum multo excedentes; dentes 6 -- 8 mm longi; dens carinalis 6 -- 7 mm latus, quam alii triplo vel quadruplo latior; glabri venulis marginibusque appresse atro-pilosis exceptis. Vexillum 12 -- 13 mm longum, 7 -- 8 latum, oblongum. Alae 13 mm longae, 3 mm latae quam carina duplo longiores. Petala carinae 6,5 -- 7,0 mm longa, 2 mm lata. Androecium 6,5 -- 7,0 mm longum; stamen decimum tertio inferiore vaginae adaxiliter fissae connatum.

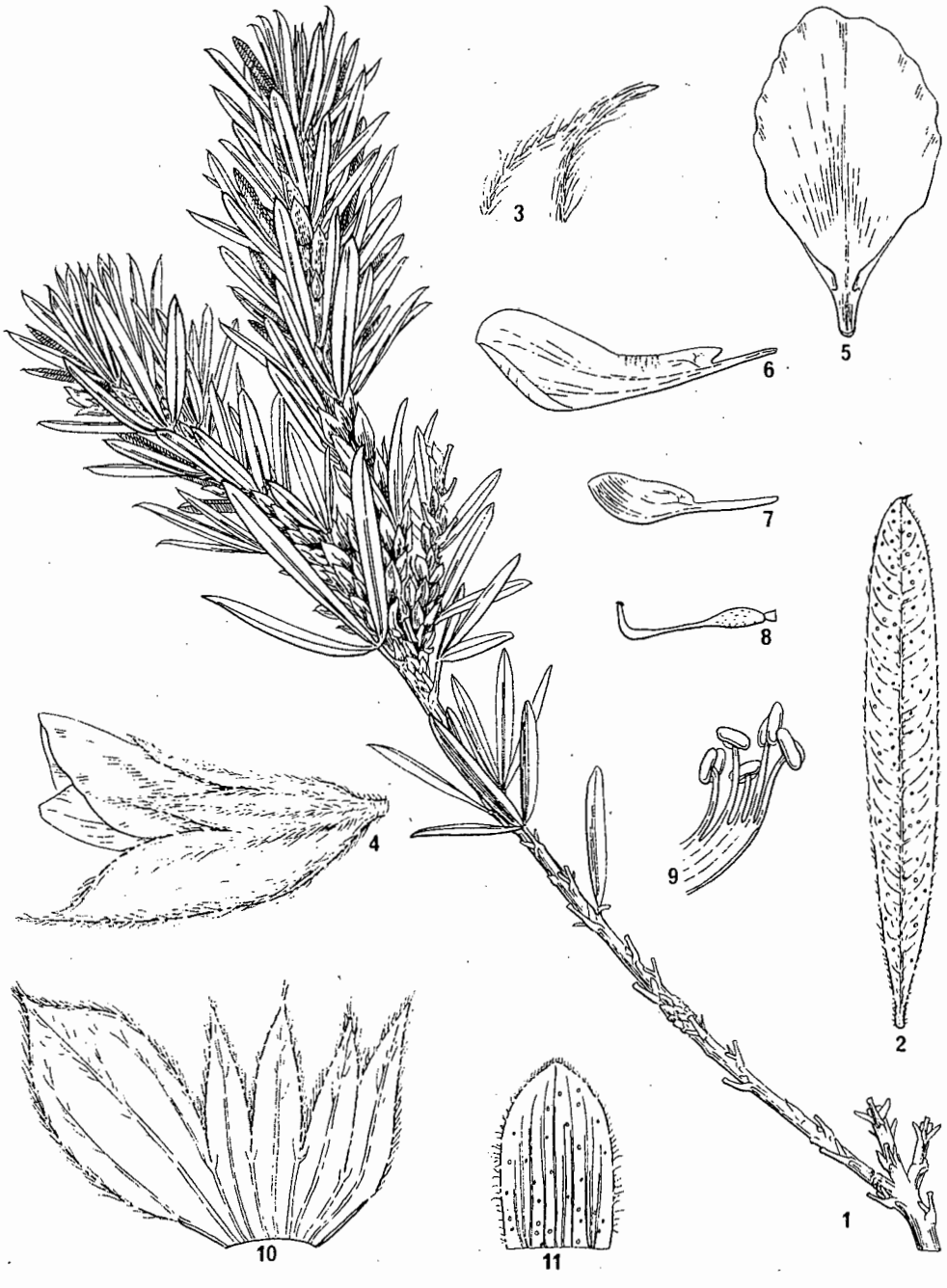


Fig. 9.75 *Otholobium nitens*. 1, Flowering branch, $x^4/_5$; 2, Terminal leaflet, x2,5; 3, Apex of terminal leaflet, x10; 4, Side view of flowers x3,5; 5, Standard, x3,5; 6, Wing petals x3,5; 7, Keel petal, x3,5; 8, Pistil, x3,5; 9, Upper part of androecial sheath split in half to show arrangement of filaments, x14; 10, Calyx opened out, inner face, x3,5; 11, Triplet bract, x5 (*Esterhuysen 30375*).

Pistillum 6 -- 7 mm longum, ovarium 1,5 mm longum sparse glandulosum, parte curvata 1,5 mm alta; stigma penicillatum. Fructus 5 mm longi, 3 mm lati, reticulati, glabri. Semina 4 -- 5 mm longa, 2 -- 3 mm lata, castanea, hilo centrali.

Erect, densely branched, somewhat cylindrical shrub up to 1,5 m tall. **Stems** one to many, pubescent, nitid when villous, internodes short. **Leaves** digitately trifoliolate, petiolate, ascending, aggregated at the ends of short seasonal shoots. **Leaflets** 20 -- 30 (35) mm long, 3,0 -- 3,5 (11,0) mm wide; laterals arcuate, assymetrical, about $^{2/3}$ length of terminal leaflet; narrowly obovate to obovate, recurved-mucronate, base cuneate, margin finely crenate; surface nitid, densely glandular, glands either sunken or evident only as bumps on the surface, pellucid, drying blackish or reddish brown; glabrous, young leaflets prominently appressed sericeous along midrib and margins; petiole 3,5 -- 4,0 mm long, persistent after leaf abscission; petiolules 1 mm long. **Stipules** 3 -- 5 mm long, 3 mm wide, longer than petioles, obliquely ovate-lanceolate to triangular, striate, membranous, glandular, clasping, pubescent. **Inflorescences** axillary on short shoots, pedunculate, pedicellate; peduncle 5 -- 7 mm long, comprised of a single triplet of flowers; each triplet subtended by an ovate, 5 mm long, 4 mm wide, black-haired, glandular bract. **Flowers** 11 -- 13 mm long, bluish-mauve. **Calyx lobes** unequal, 10 -- 12 mm long; much longer than the tube; teeth 6 -- 8 mm long; carinal tooth 6 -- 7 mm wide, 3 -- 4 times wider than other teeth; glabrous except for appressed black hairs along the veins and margins. **Standard** 12 -- 13 mm long, 7 -- 8 mm wide, oblong to elliptic, scarcely auriculate; claw 2 mm long; apex emarginate, glabrous. **Wing petals** 13 mm long, 3 mm wide, claw 3 mm long; twice as long as keel blades; sculpturing upper basal and left central, comprised of a single row of up to 20 transcostal lamellae. **Keel petals** 6,5 -- 7,0 mm long, 2 mm wide, claw 2,0 -- 2,5 mm long, apex slightly beaked. **Androecium** 6,5 -- 7,0 mm long, vexillar stamen fused to lower third of adaxially split sheath, anthers 1 -- 2 mm long, equal. **Pistil** 6 -- 7 mm long; ovary 1,5 mm long, sparsely glandular; height of

curvature 1,5 mm high; stigma penicillate. **Fruits** 5 mm long, 3 mm wide, papery, reticulate, glabrous. **Seeds** 4 -- 5 mm long, 2 -- 3 mm wide, chestnut brown, hilum central. Fig. 9.75.

Otholobium nitens is a rare occasional plant which grows in Mesic Mountain Fynbos (Fig. 9.76), usually on steep rocky slopes with a southerly aspect at 700 -- 1200 m altitude. Flowering takes place from late October to late December with a peak in November.

The greatest concentration of this species occurs in the Slanghoek, Dutoits Kloof and Wemmershoek Mountains. The plants growing in these areas are characterised by the narrowness and shininess of their leaves and the large characteristic keel lobe of the calyx fringed with long black hairs. To the south of these populations there are some isolated colonies in which the flowers are smaller, the keel lobe of the calyx much narrower and the leaves much broader becoming distinctly obovate. Typical examples include *Kerfoot 5523* (Jonkershoek), *Esterhuysen 35814* (Franschhoek Mountains) and *Rycroft 1453* (Kogelberg Peak). These specimens may constitute a distinct taxon but more material needs to be collected as the available material is depauperate. Another atypical specimen is *Esterhuysen 29919*. This is a laxer plant with narrower sepals and with leaves intermediate in shape and gland concentration and type. It has the facies of a hybrid and should be sought after.

O. nitens is related to *O. mundianum* (Eckl. & Zeyh.) C.H. Stirton and can be separated from that species by the characteristically numerous dense and variously sized internal pellucid glands of its leaves, the broad black haired carinal tooth of the calyx and the wing petals which are more than twice as long as the keel petals. The two species may be keyed out as follows:

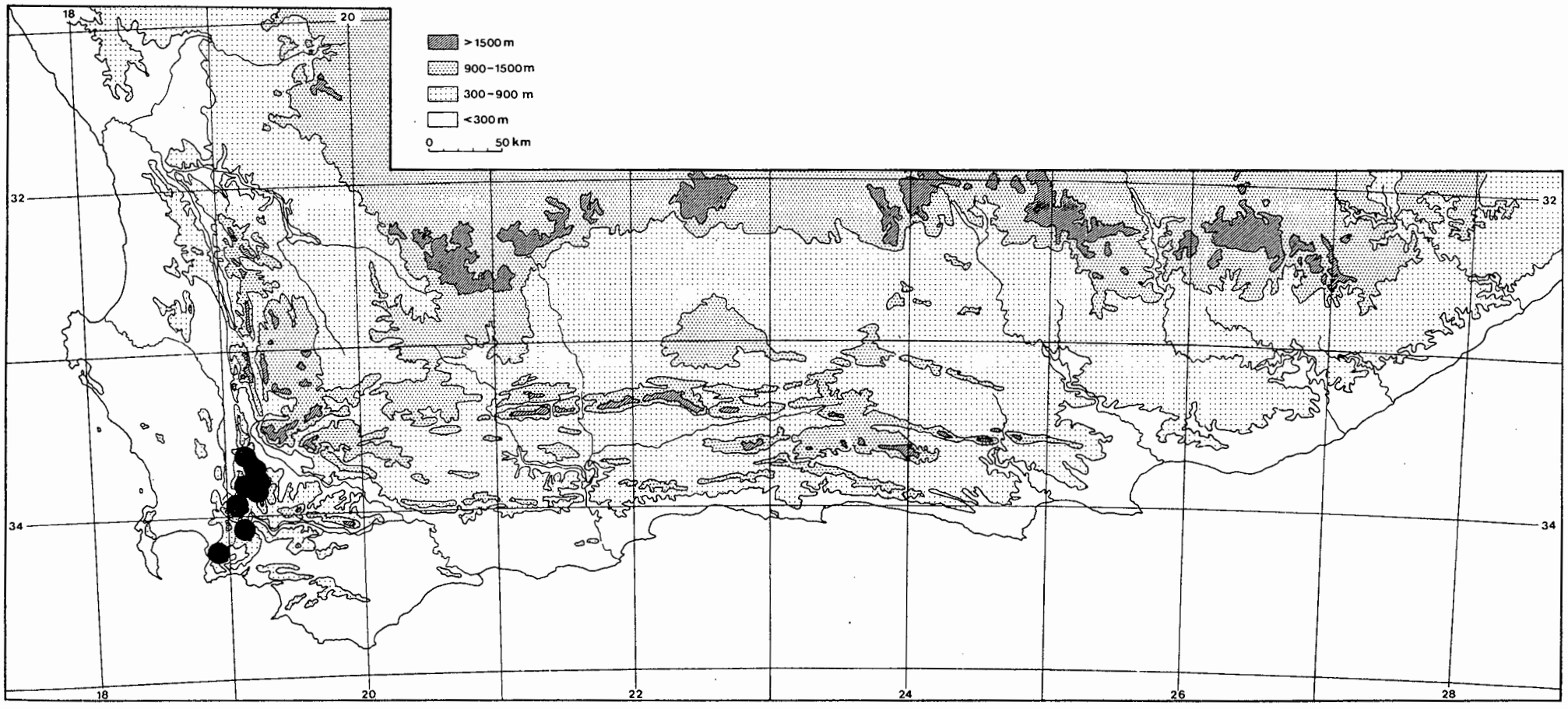


Fig. 9.76 Known distribution of *Otholobium nitens* C.H. Stirton in southern Africa.

Leaves densely glandular, glands variously sized, sunken or below the surface, drying black; wing petals twice as long as the keel petals; carinal lobe of the calyx three times broader than the other teeth, with long appressed black hairs along the margin ..... *O. nitens*

Leaves sparsely glandular, glands more or less evenly sized, raised, drying reddish orange; wing petals one third longer than the keel petals; carinal lobe of the calyx less than twice as broad as the other teeth, sparsely covered in long white hairs ..... *O. mundianum*

Specimens examined

-3318 (Cape Town): Langrivier, Jonkershoek (--DD), 12-1965, *Kerfoot 5523* (STE).

-3319 (Worcester): Dutoitskloof (--CA), *Drège* s.n. (G); south west slopes of Langhoek Needle (--CA), 19-11-1950, *Esterhuysen 17805* (BOL); Molenaarsberg (--CA), 6-10-1963, *Esterhuysen 30356* (BOL); Haelhoek Sneeukop (--CA), 16-2-1975, *Esterhuysen 34159* (BOL, MO); Observation Point, Bainskloof Mountains (--CA), 23-1-1982, *Esterhuysen 35743* (BOL, K); Upper Wellington Sneeukop (--CA), 14-12-1980, *Esterhuysen 35595* (BOL, K); Chavonnesberg (--CB), 1-12-1962, *Esterhuysen 29919* (BOL, K); Roesbos Peak, Franschhoek Mountains (--CC), 14-11-1982, *Esterhuysen 35814* (mixed gathering, BOL, K).

-3419 (Caledon): Krom Rivier Kloof (--AA), 10-10-1963, *Esterhuysen 30375* (BOL, K, MO, NBG); Summit of 5 Beacon Ridge, Kogelberg Forest Reserve (--BD), 30-11-1952, *Rycroft 1453* (BOL, K, NBG).

Without precise locality: Seven Sisters Mountain, 14-11-1954, *Esterhuysen 23937* (BOL).

34. Otholobium parviflorum (E. Mey.) C.H. Stirton in S. Afr. J. Bot. 52: 3 (1986).

Psoralea parviflora E. Mey., Comm. 86 (1836). Lectotype: "Dutoitskloof, III A e", *Drège* s.n. (K, lecto; G, GBH, L, MO, PRE, iso).

Suffrutex up to 1 m tall. **Stems** up to 50, coppicing after fire; verrucose, prominently papillose and glabrescent when young. **Leaves** digitately trifoliolate, inserted spirally, spreading; terminal leaflet 30 -- 34 mm long, 10 -- 20 mm wide, elliptic, laterals slightly smaller, scarcely assymetric; stem leaflets much larger than those borne on flowering shoots, all leaves becoming smaller upwards towards the apex; apex recurved-mucronate, base truncate, glabrous, densely glandular; rachis channelled above; petiolule 3 mm long, glandular; petiole 2 -- 3 mm long. **Stipules** 6 mm long, 1,5 mm wide, recurved-patent, pubescent, rapidly cauducous. **Inflorescences** terminal, densely racemose on leafy shoots 90 -- 100 mm long, comprised of 23 -- 25 triplets of sessile flowers, each triplet subtended by a single, pubescent 3 -- 7 mm long, 3,0 -- 4,3 mm wide, broadly ovate bract with an acute apex; bracts become smaller near the apex of the inflorescence. **Flowers** white to pale cream, 8 -- 10 mm long. **Calyx** scarcely longer than the keel blades; carinal lobe longest, 8 -- 9 mm long, 1,5 mm wide; other lobes 7 mm long; tube 3 -- 4 mm long; yellowish-green with carinal lobe and veins a darker green, pubescent and glandular outside, finely pubescent on the inner face of teeth. **Standard** 8,0 -- 9,5 mm long, 6 -- 7 mm wide, elliptic; claw 2 -- 3 mm long, auriculate; appendages absent; apex emarginate. **Wing petals** 2,5 -- 3,0 mm longer than the keel; 9 mm long, 3 mm wide with 3,0 -- 3,5 mm long claw, billowy at tip; sculpturing present, upper central comprised of 1 -- 2 rows of 13 vertical, irregular, transcostal lamellae. **Keel petals** 4 -- 7 mm long, 2 mm wide, with 3,0 -- 3,5 mm long claw. **Androecium** sheath 6 mm long, split

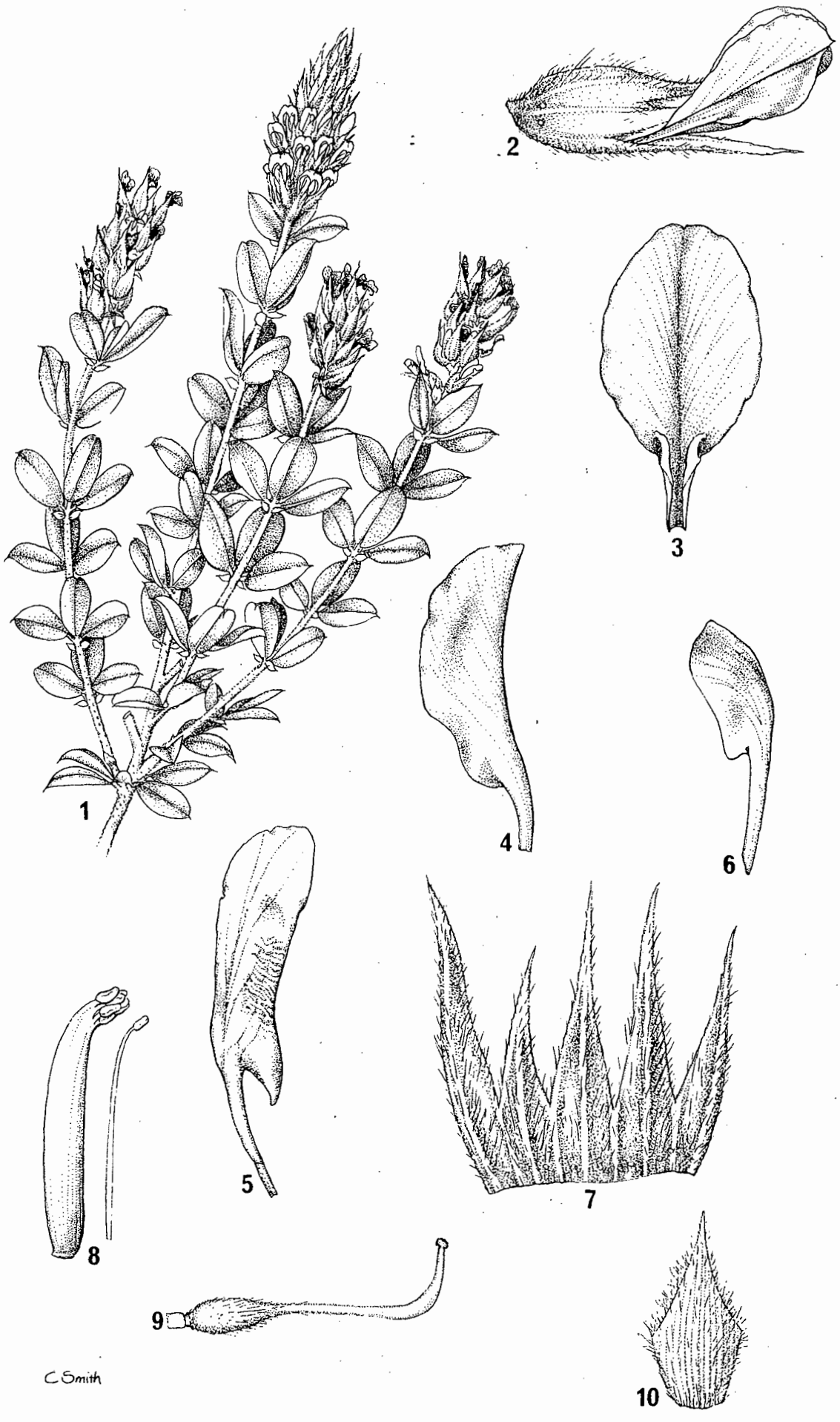


Fig. 9.77 *Otholobium parviflorum*. 1, Flowering branches, x1; 2, Side view of flower, x6; 3, Standard, inner face, x6; 4, Standard, side view, before reflexion, x6; 5, Wing petal, x6; 6, Keel petal, x6; 7, Calyx opened out, outer view, x6; 8, Androecium, vexillar stamen free x6; 9, Pistil, x6; 10, Triplet bract, x6 (*Stirton 9938*).

adaxially; vexillar stamen free. **Pistil** 4,0 -- 6,5 mm long; ovary 1,5 -- 2,0 mm long, pubescent; height of curvature of style 1,0 -- 1,7 mm high, thickened at point of flexure; stigma small, penicillate. **Fruits** and seeds unknown. Fig. 9.77.

Otholobium parviflorum is a species of early successional stages in Mesic Mountain Fynbos on Table Mountain Sandstone (Fig. 9.78). Flowering occurs between October and November. It is restricted to the lower slopes of the mountains stretching from Jonkershoek in the south to Du Toits Kloof Pass in the north.

In the past this species has been incorrectly identified as *Psoralea fruticans* (L.) Druce. The name *P. parviflorum* E. Mey. has never been taken up in herbaria. *O. parviflorum* is, however, a very distinctive species, being easily separated from *O. fruticans* by its characteristic verrucose stems, pale cream to white flowers, and multi-stemmed erect habit. The flowers dry yellow.

O. parviflorum hybridizes with *O. obliquum* (E. Mey.) C.H. Stirton. The latter species grows among Table Mountain Sandstone outcrops, usually along the crests of ridges, whereas the former occurs at lower elevations on more gentle slopes. The hybrid, growing at the edge of rocky outcrops, is a soft, up to 60 stemmed, erect herb with lax branching near the apex. The leaves are spreading. Inflorescences are either axillary (3 -- 5 flowers) or terminal (up to 25 flowers) or in various combinations. The standard is pale mauve with a dark mauve nectar patch. (Voucher: *Stirton 9939).*

Specimens examined

-3318 (Cape Town): mountains near Wellington (--DB), 11-1882, *Tyson 917* (BOL, NH); Jakkalavlei (--DC), 20-11-1962, *Taylor 4377*, (PRE, STE); 12-11-1965, *Taylor 6592* (PRE,

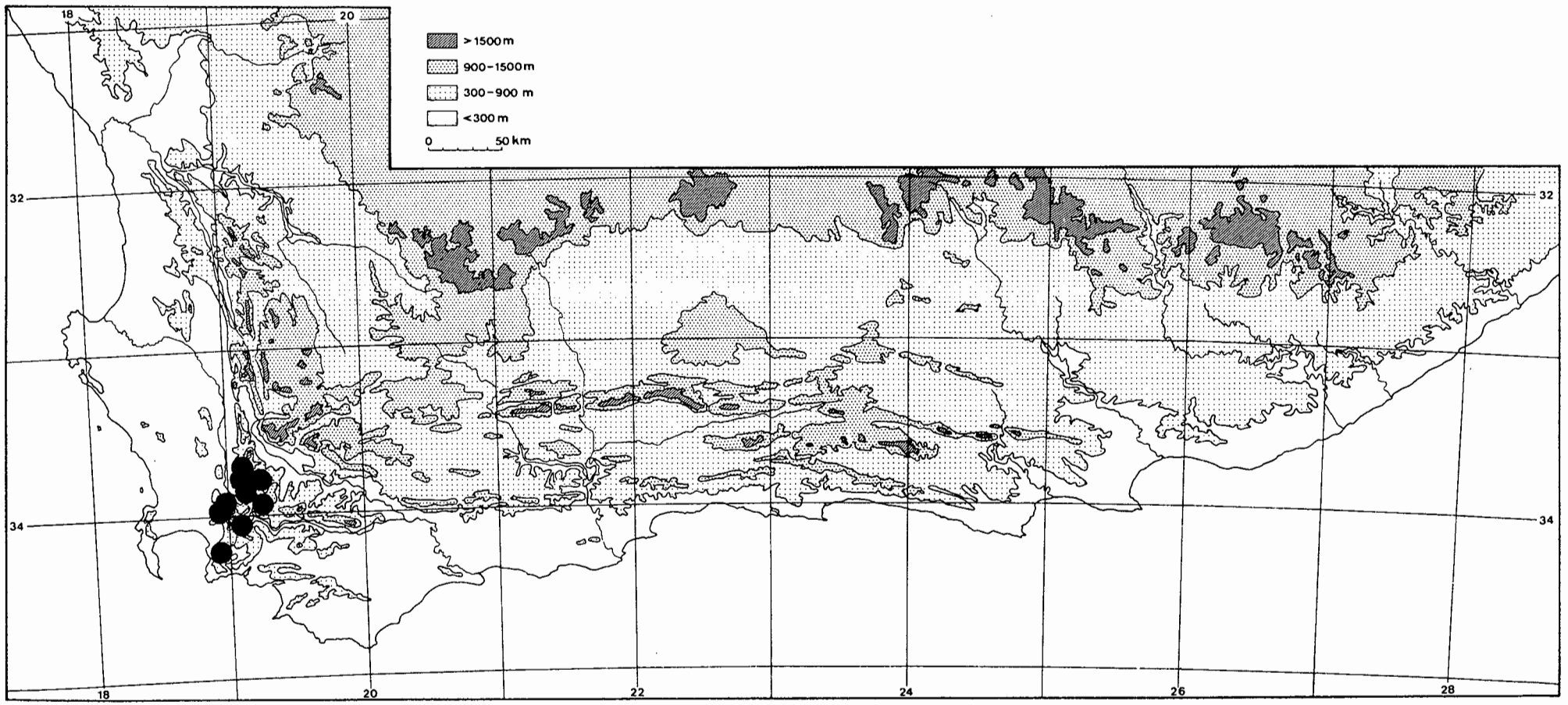


Fig. 9.78 Known distribution of *Otholobium parviflorum* (E. Mey.) C.H. Stirton in southern Africa.

STE); Jonkershoek (--DD), 25-10-1950, *Parker 4535* (BOL, K, NBG); 7-11-1943, *Parker 15317* (NBG); 19-1-1975, *Esterhuysen 33749* (BOL); *Goldblatt 6812* (MO, PRE); *Kruger 33, 42, 49, 333* (PRE, STE); 9-11-1918, *Garside 1163a* (K, STE); 14-12-1960, *Grobbelaar 249* (PRE, PRU); 14-12-1966, *Grobbelaar 1589* (PRE); 24-12-1925, *Marion* s.n. (BOL); Swartboskloof (--DD), 25-10-1960, *Van Der Merwe 2381* (K, PRE, STE); 9-11-1982, *McDonald 777* (PRE, STE), 28-10-1982, *855* (PRE, STE); 11-12-1975, *Kruger 103* (STE); 9-6-1960, *Van Der Merwe 2221* (STE); 18-9-1960, *Van Der Merwe 2358* (STE); 17-10-1960, *Van Rensberg 2120* (PRE); Langrivier Catchment (--DD), 6-3-1975, *Haynes 1011* (PRE); Stellenbosch golf-course (--DD), 17-10-1960, *Van Der Merwe 2120* (STE).

-3319 (Worcester): Du Toits Kloof Pass (--CA), 10-10-1959, *Acocks 20635* (K, PRE); 1-1880, *Bolus 5158* (BOL, K); *Drege* s.n. (K, PRE); *Gentry & Barclay 18729* (K, PRE, US); Elandspad (--CA), *Walters 13444* (NBG); Bushman's Castle, Franchhoek Mountains (--CC), 25-12-1936, *Salter 6551* (BOL, K); rocky slopes above Wemmershoek Valley (--CC), *Esterhuysen 17670* (BOL); 14-12-1940, *Compton 10131* (NBG); Du Toits Kloof (--CC), 28-12-1952, *Esterhuysen 20992* (BOL, PRE); *Grobbelaar 2704* (PRE); 12-1951, *Stokoe* s.n. (SAM 69596); Bakkerskloof (--CC), 18-1-1978, *Van Wilgen 218* (STE); Drakenstein Mountains (--CC), 1-1812, *Tyson 2436* (NH); Bergrivier Hoek (--CC), 1-1-1940, *Compton 8315* (NBG).

-3418 (Simonstown): Aries Kraal (--BD), 18-11-1944, *Leighton 767* (BOL); 26-12-1941, *Bond 1303* (NBG); 11-11-1944, *Compton 16472* (NBG); 11-1944, *Lewis 915* (SAM); boundary of Kogelberg State Forest and Somersfontein Farm (--BD), 22-11-1974, *Boucher 2691* (STE).

-3419 (Caledon): near Elgin, between Grabouw and Paardeberg (--AA), 12-1947, *Stokoe*

s.n. (SAM 56394); 7-12-1984, *Jaarsveld & Sardien 7682* (NBG).

Without precise locality: *Burmann* s.n. (G); Baileys Peak, 19-11-1967, *Esterhuysen 31806* (BOL); Berg Rivier Hoet, 16-12-1945, *Esterhuysen 12408* (BOL).

35. Otholobium stachyerum (Eckl. & Zeyh.) C.H. Stirton in S. Afr. J. Bot. 52: 4 (1986).

Psoralea stachyera Eckl. & Zeyh., Enum. 230 (1836); Walp., Repert. 1: 657 (1842). Lectotype: "In locidis et pratensibus ad fluminis ripam Zwartkopsrivier", *Ecklon & Zeyher* s.n. (S, lecto; G, K, MEL, MO, iso).

Psoralea cephalotes Eckl. & Zeyh., Enum. 230 (1836) non E. Mey. (1836). Syn. nov. Lectotype: "In humidis laterum montis Winterberg prope Phillipstown", *Ecklon & Zeyher* s.n. (S, lecto; S, iso). The right hand specimen of this mixed collection sheet is selected here as the lectotype. The other two twigs belong to *O. bracteolatum* (Eckl. & Zeyh.) C.H. Stirton. I have only come across two specimens of *P. cephalotes*. The other one is in bud only and was unlikely to have been used as a basis to describe the species. The E. Meyer name refers to *O. uncinatum* and is a nom. illeg.

Psoralea densa E. Mey. was referred to this species by Walpers in Linnaea 13: 514 (1839). *P. densa* is a synonym of *O. acuminatum* (Lam.) C.H. Stirton.

Tall erect shrub up to 2 m tall. **Stems** 1 -- few, appressed puberulent, much branched in the upper half, lax. **Leaves** digitately trifoliolate, stipulate, shortly petiolate. **Leaflets** subequal, terminal 10 -- 20 mm long, 8 -- 10 mm wide, sometimes much reduced and 8 -- 10 mm long to 5 -- 6 mm wide on seasonal shoots, especially towards the terminal inflorescence, laterals small; symmetrical, apex emarginate, mucro sharp, recurved, 0,5 -- 1,0 mm long, base obtuse to acute, obovate to broadly obovate; glands crateriform when dry, more or less equal, numerous, about same number on each surface; young leaflets hairy on midrib and margins, persisting in mature leaflets only on

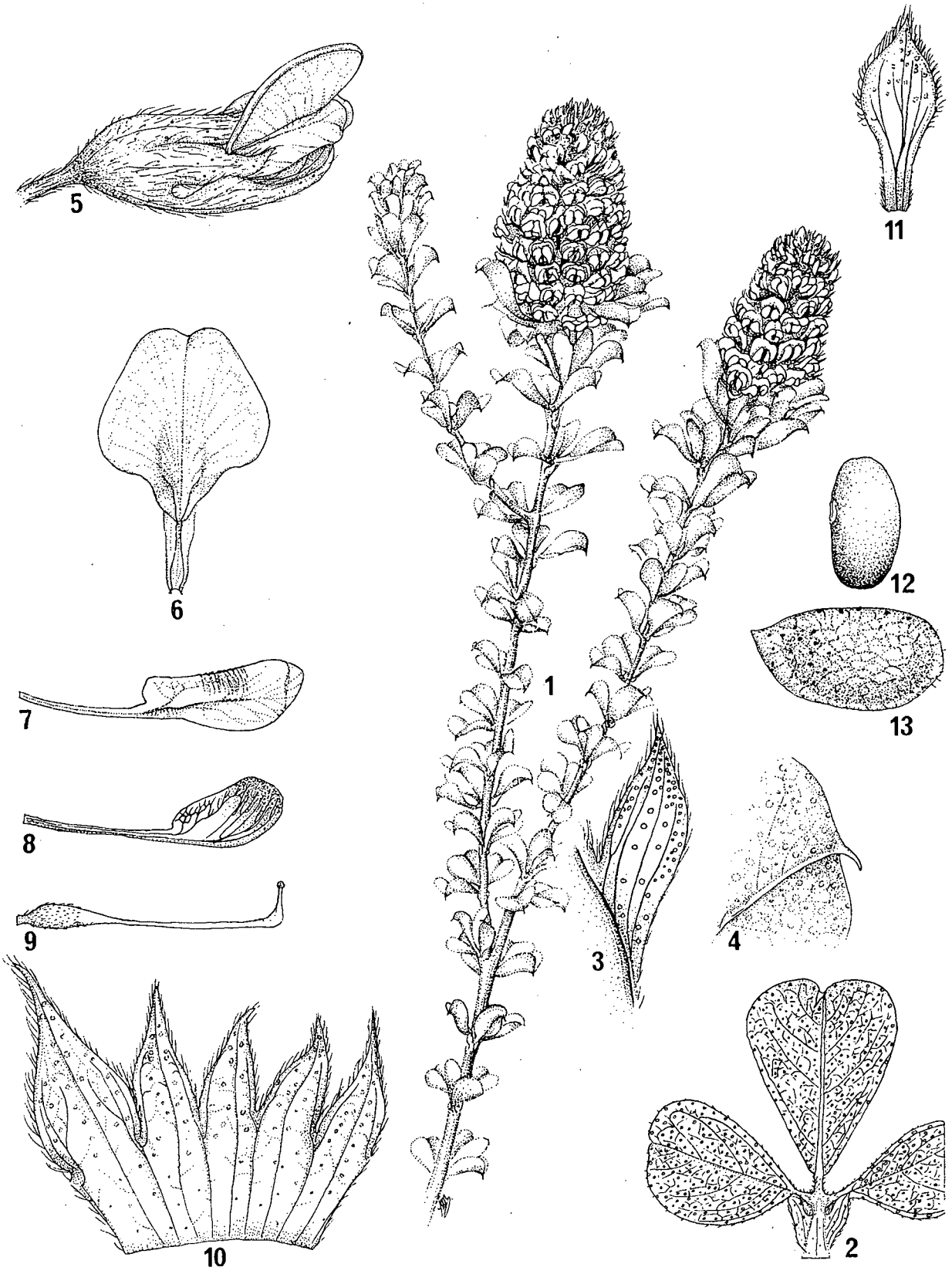


Fig. 9.79 *Otholobium stachyerum*. 1, Flowering shoot, x1; 2, Digitately trifoliolate leaflet, terminal showing lower surface, laterals showing upper surface, x2,5; 3, Stipule, x8; 4, Apex of terminal leaflet, x5; 5, Flower, x6; 6, Standard, x6,5; 7, Wing petal, x7; 8 Keel petal, x7; 9, Pistil, x7,5; 10, Calyx opened out, x9; 11, Triplet bract, x7; 12, Seed, x7; 13, Fruit, x8 (1, *Esterhuysen 6967*; 2-13, *Stirton 9620*).

the midrib; petiole 3 mm long, petiolules 1,3 -- 1,5 mm long. **Stipules** 2,5 -- 5,5 mm long, up to 1,5 mm broad, clasping, subulate, sericeous, persistent. **Inflorescences** terminal on 10 -- 30 cm long, laxly leafy, seasonal shoots, 15 -- 20 mm long, elongating during anthesis from 15 to 40 mm, each comprised of 20 -- 25 triplets of shortly pedicellate flowers, each triplet subtended by a broadly lanceolate, 4 -- 6 (8) mm long, 2,0 -- 2,5 mm wide, 4 -- 5 nerved sometimes irregularly toothed, black-haired glandular bract, size decreasing near the apex, caducous. **Flowers** 8 -- 9 mm long, purplish-blue to rose-pink with reddish nectar patch, pedicel 2 mm long; nectar copious but odourless. **Calyx** two-thirds the length of the corolla; lobes subequal, teeth spreading at anthesis, carinal lobe longest, 6,0 -- 6,5 mm long, 2 mm wide, 0,5 mm wider than other lobes; about same length of tube between all teeth, carinal tooth lanceolate, triangular, acute, vexillar pair fused slightly above tube; sericeous, white or black-haired, glands prominent, equal in number on both surfaces. **Standard** 7 -- 9 mm long, 5,0 -- 5,5 mm wide, claw 2,5 -- 3,0 mm long, auriculate, apex emarginate, broadly elliptic. **Wing petals** 7 -- 9 mm long, 2 mm wide, claw 3 mm long, longer than keel petals but not fused to them, pale pink, auriculate, sculpturing present, upper central, comprised of 6 -- 8 thick transcostal lamellae. **Keel petals** 5 -- 7 mm long, 2 mm wide, claw 4 mm long. **Androecium** 7 mm long, vexillar stamen fused for half its length, sheath lightly fused in lower half, fenestrate. **Pistil** 6 mm long, ovary 2 mm long, glandular, hairy on dorsal ridge, entasis present, broadest at point of flexure, height of curvature 1,2 -- 1,3 mm long, stigma capitate. **Fruits** 4 mm long, 2 mm wide, reticulate, papery, brittle, sparsely pulverulent. **Seed** 2,5 -- 3,0 mm long, 1,7 -- 1,8 (2,0) mm long, dark brown, chesnut or olive with purple flecks (inland, Kologha Forest); hilum round, 0,5 -- 0,6 mm long. Fig. 9.79.

Otholobium stachyerum is a rather variable and widespread species in the southern and eastern Cape regions (Fig. 9.80). Flowering takes place throughout the year with peaks in June/July and December/January. It occurs at altitudes between 200

-- 2000 m. The plants grow in grassland or along forest margins and regenerate by seed, especially after fires. As *O. spicatum*, *O. hirtum* and *O. bracteolatum* this species produces large quantities of seed. They generally form large stands in areas which are burnt frequently. Plants may, however, grow quite large and persist for up to 10 years.

At the extremes of their ranges the two taxa segregated by Ecklon & Zeyher (*Psoralea cephalotes* & *P. stachyerum*) would seem to be quite distinct. However, there is a distinct gradation from the southwest to the northeast in inflorescence and flower size, flower colour, degree of pubescence and robustness of the plants.

Keet in a note on his collection *Keet 15* mentions that this species is used in the Concordia area to smoke fish and hams.

Specimens examined

-3226 (Fort Beaufort): Fort Fordyce (--CB), 12-3-1947, *Story 2106* (GRA, PRE);

-3227 (Stutterheim): Fort Cunnighame (--AD), 12-6-1972, *Van Gadow 149* (GRA); 1897, *Sim* s.n. (PRE 20288); Cata Valley, 22-3-1950, *Acocks 15746* (PRE); mountains W of Keiskamma Valley (--CA), 25-1-1957, *Gibbs Russell 3498* (GRA, NU); Dohne Peak (--CB), 5-7-1942, *Acocks 8956* (PRE); Komgha (--DB), 1890, *Flanagan 403* (GRA, PRE);

-3322 (Oudtshoorn): near Yzernek and Hartebeest Flats (--CC), 3-14-1814, *Burchell* s.n. (K); George (--CD), 1-1916, *Paterson* s.n. (GRA); 16-3-1893, *Schlechter 2349* (G, K, MEL 1542065, PRE, STE); Kammanassie Mountains (--DB), 1-1940, *Stokoe 764* (BOL, SAM 54665); Wilderness (--DC), 8-1923, *Levyns 764* (BOL); 1-5-1941, *Compton 10714*

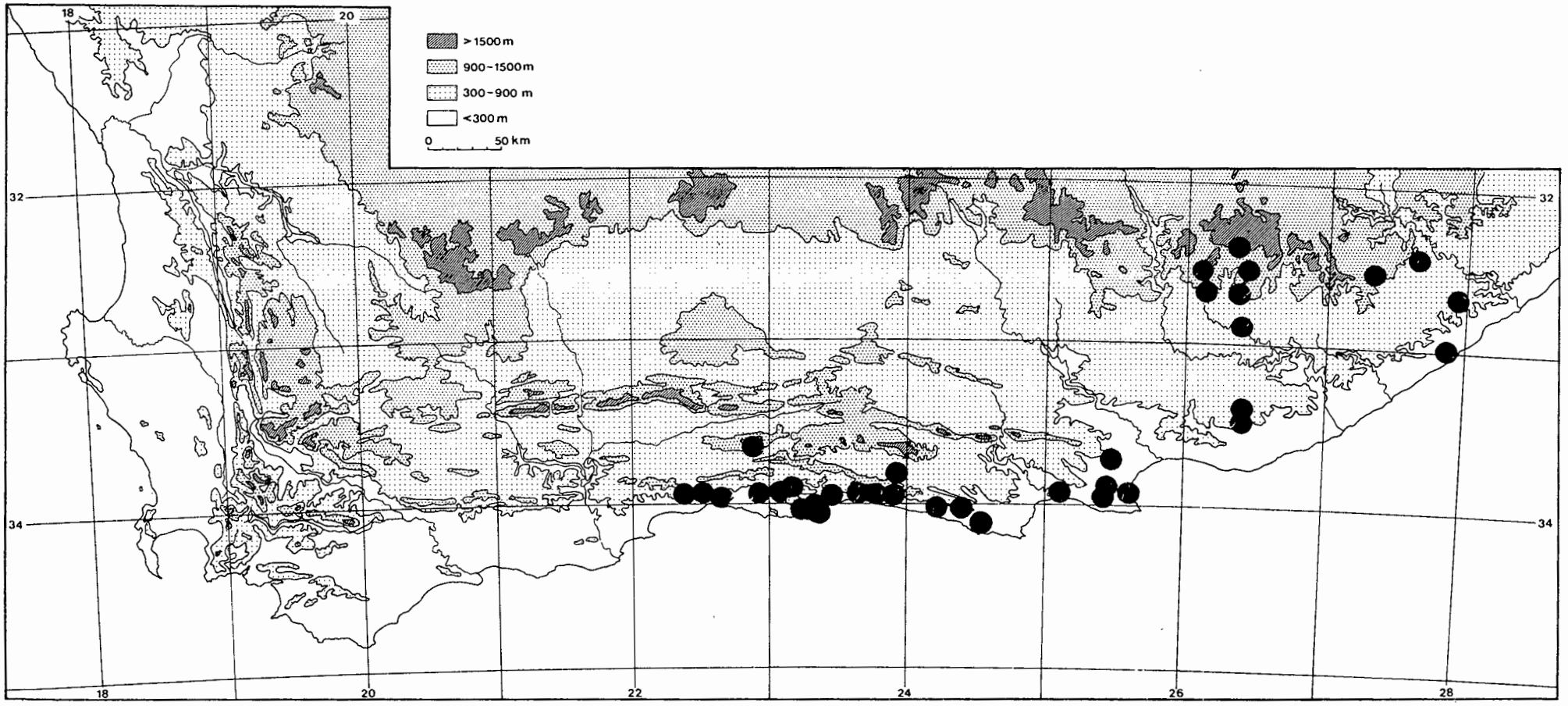


Fig. 9.80 Known distribution of *Otholobium stachyerum* (Eckl. & Zeyh.) C.H. Stirton in southern Africa.

(NBG); The Crags (--CD), *Wurts 2036* (NBG); 12 km E of Plettenburg Bay (--CD), 6-12-1921, *Barclay & Acocks 940* (PRE); Groenkop Block B, Saasveld (--DC), 19-1-1976, *Van Daalen 11* (SAAS, STE); Natures Valley (--DC), 3-10-1981, *Stirton 9631* (K, PRE).

-3323 (Willowmore): Knysna Forest (--CC), 13-7-1951, *Gray* s.n. (BOL); Forest hall (--CD), 25-1-1922, *Duthie 740* (GRA, STE); 5-1908, *Fourcade 157* (GRA); Groot River Mouth (--DC), 4-8-1981, *Parsons 174* (STE); Coldstream (--DC), 2-4-1929, *Galpin 9529* (K); 6-1947, *Britten 66* (GRA); Joubertina (--DD), 26-11-1941, *Esterhuysen 6967* (BOL, NBG);

-3325 (Port Elizabeth): Sandfontein, Near Coega River (--CB), 7-11-1813, *Burchell 4220* (K); between Van Stadens and Galgebosch, 11-2-1814, *Burchell 4677* (K); Hofmans Bosch (--CD), 29-1-1918, *Britten 1028* (GRA, PRE); Villa Paul Mare (--CD), *Ecklon & Zeyher* s.n. (MEL 1542127); Swartkopsrivier (--DC), *Drège* s.n. (E, K); *Ecklon* s.n. (G, K, MEL 1549, MO); Vaal Vlei Estate (--DC), 31-5-1919, *Mogg 4736* (PRE);

-3326 (Grahamstown): Faraway, Grahamstown (--AD), 7-11-1981, *Jacot Guillarmod 8715* (E, GRA, PRE); 27-9-1984, *Stirton & Schrire 10776* (K); Grahamstown (--AD), *Liebenberg 283* (PRE); 1923, *Britten* s.n. (GRA); Blackhome Hill (--BA), *McOwan* s.n. (K, MEL 1542055); Grahamstown Nature reserve (--BC), 4-8-1976, *Booi* s.n. (PRE);

-3327 (East London): East London (--BB), 2-1908, *Rattray 186* (GRA).

-3419 (Caledon): near Grootbos on road to Baviaansfontein (--CB), 6-10-1981, *Stirton 9747* (PRE);

-3420 (Bredasdorp): Windhoek (--CA), *Van der Merwe 1929* (STE).

-3423 (Knysna): Plettenburg Bay (--AB), *Pappe* s.n. (K); 54 km E of Knysna (--AB), 4-12-1952, *Godfrey* s.n. (PRE, US); Keurboomsrivier (--AB), *Drège* s.n. (G, K, P, PRE).

-3424 (Humansdorp): Witte Els Bosch (--AA), 2-1926, *Thode 804* (PRE); Jaftaskraal (--AB), 11-12-1975, *Van Rooyen 667* (PRE); Clarkson (--AB), 6-1926, *Thode 805* (K, PRE); Slang River (--BA), 8-12-1921, *Spearman 10* (PRE).

Without precise locality: *Barber 31* (TCD); *Boivin* s.n. (E, G); 1860, *Cooper 44* (K); British Caffraria, 1860, *Cooper 383* (K, TCD); Kaffirskop, 25-8-1978, *De Beer 1* (SAAS); *Flannagan 396* (PRE); 11-1838, *Krauss* s.n. (G, TUB); Cap., *Verreaux* s.n. (G); Albany area, *Williamson* s.n. (TCD).

36. Otholobium pictum C.H. Stirton in Jl. S. Afr. Bot. 49: 340 (1983). Holotype: Baviaanskloof Mountains, between Smitskraal and Wilgehof, *Oliver 4588* (STE, holo; BM, G, K, PRE, iso).

Erect shrubs up to 2 m tall. **Stems** slender, glabrous, weakly ribbed, yellowish brown. **Flowering shoots** clustered at the ends of the previous years growth, densely appressed white canescent between the angles, with occasional elliptic pustules scattered along the upper edges. **Leaves** digitately trifoliolate. **Stipules** 2,5 -- 3,0 mm long, 0,5 -- 0,8 mm wide, fused to the base of the petiole, shortly triangular, scarcely pubescent, densely encrusted with orange glands especially at the base. **Leaflets** 15 -- 25 mm long, 2,5 -- 3,0 mm wide, flat, glabrescent, prominently nigro-punctate in dried specimens, denser on upper surface, impressed, oblanceolate to oblong, somewhat falcate, base cuneate, apex recurved mucronate; laterals shorter and narrower than terminal leaflet, slightly assymetrical; petioles 1,5 -- 2,0 mm long, gland encrusted. **Inflorescence** densely spicate, broadly-ovate becoming oblong, with 20 -- 30 triplets of flowers; each triplet subtended by a single broadly ovate, pubescent, glandular bract. **Flowers** 9 -- 10 mm long, white; subsessile. **Peduncle** absent. **Calyx** 8 mm long; upper four teeth sub-equal, 6 mm long, 1 mm wide, keel tooth 8 mm long, 1 mm wide; vexillar teeth connate for half their length above tube; lobes covered in small glands, densely black tomentose outside; tube 3,0 -- 3,5 mm deep. **Standard** 9,0 -- 9,5 mm long, 6,5 mm wide, broadly elliptic, emarginate, slightly auriculate, appendages absent; claw 2 mm long. **Wing petals** 9 mm long, 2,0 -- 2,5 mm wide, longer than the keel, auriculate, claw 3,0 -- 3,3 mm long; sculpturing upper basal, upper central and upper left distal comprised of 20 -- 26 irregularly parallel lamellae. **Keel blades** 7 mm long, 2,5 mm wide, apex rounded, claw 3,5 mm long. **Androecium** 7 mm long; vexillar stamen 6,0 -- 6,5 mm long, loosely fused to sheath for half its length. **Pistil** 6,5 -- 7,0 mm long; ovary 2,5 mm long, pubescent, gynophore 0,5 mm long; style glabrous, 0,4 mm thick at point of flexure; stigma papillose, forward sloping. **Fruits** and seed unknown. Fig. 9.81.

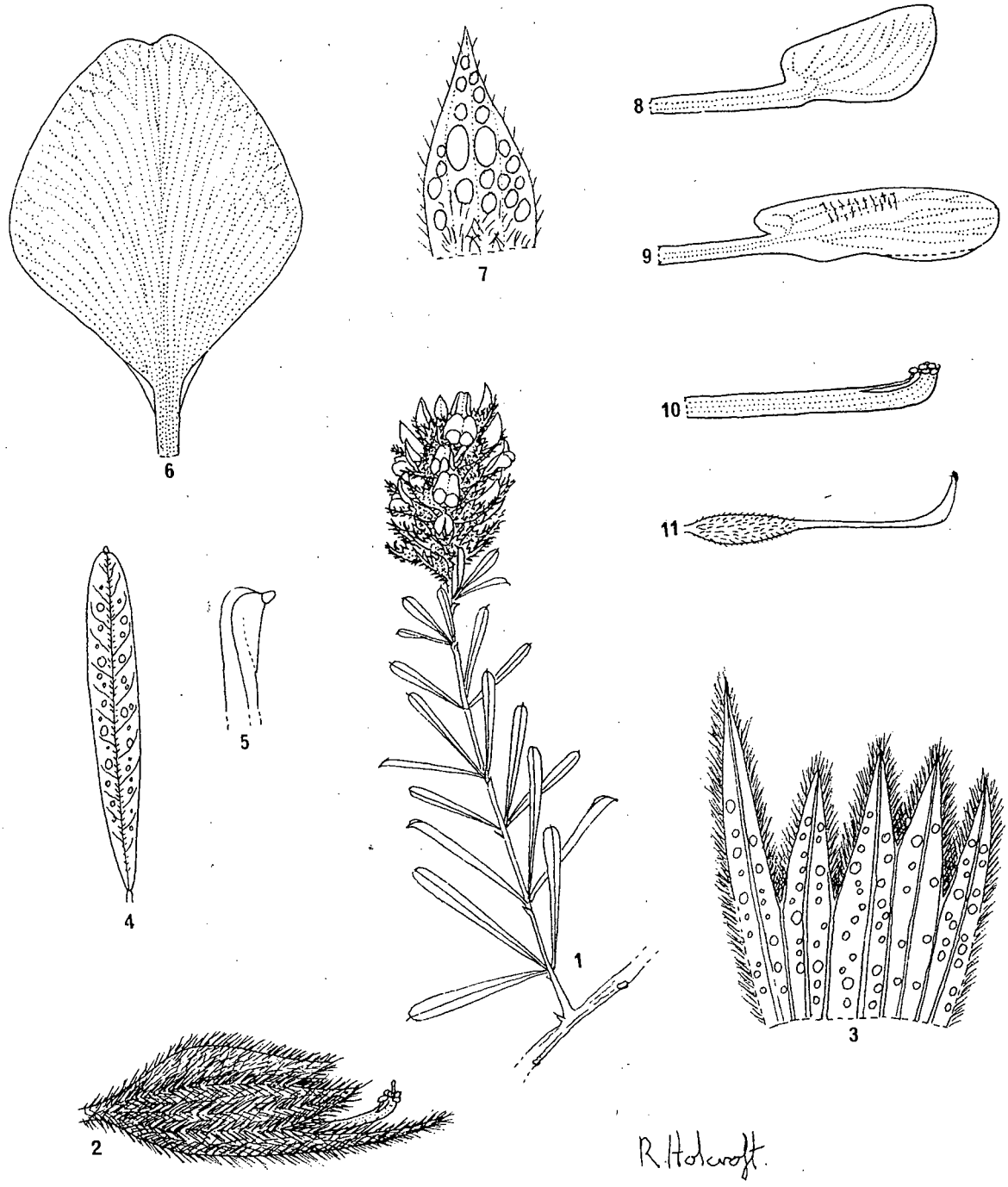


Fig. 9.81 *Otholobium pictum*. 1, Flowering branch, $x^2/_3$; 2, Fruiting calyx, x6; 3, Calyx opened out, inner face, x6,5; 4, Terminal leaflet, x1; 5, Apex of terminal leaflet, x2; 6, Standard, x6; 7, Stipule, x10; 8, Keel petal, x6; 9, Wing petal, x6; 10, Androecium, x6; 11, Pistil, x6 (*Oliver 4588*).

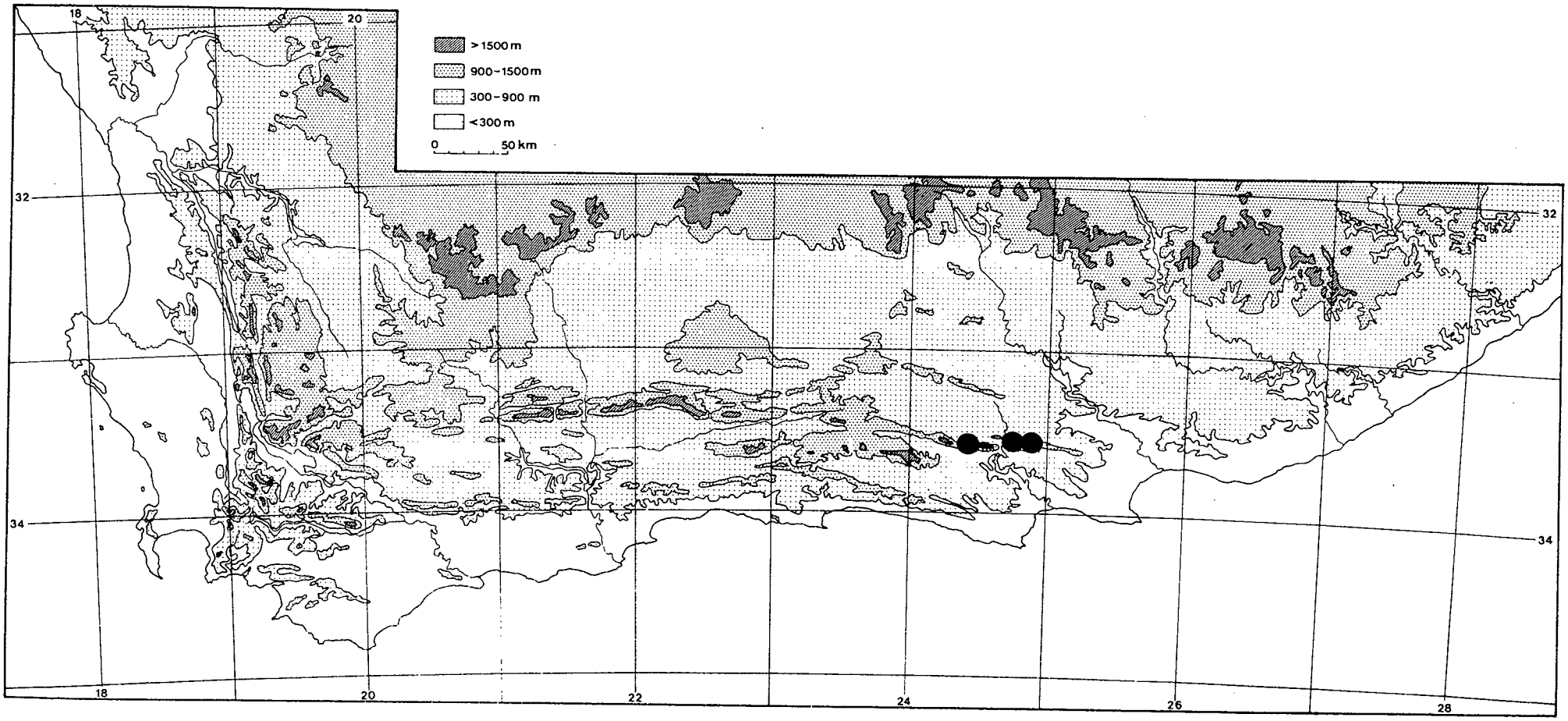


Fig. 9.82 Known distribution of *Otholobium pictum* C.H. Stirton in southern Africa.

Otholobium pictum, a distinctive endemic of the Baviaanskloof and Winterhoek Mountains (Fig. 9.82) was first collected in 1930. Since then it has been collected twice. Nonetheless it is quite surprising that such a distinctive shrub should have been without a name for so long. Given the inaccessibility of the terrain in which this distinctive species occurs it is perhaps to be expected that the only collections made so far have been along the two passable tracks across the Baviaanskloof and Great Winterhoek Mountains. It is probably fairly common on the escarpment and with further collecting by mountaineers it should have its range broadened substantially. The discovery of this species stresses once again the poor state of collecting along the inland mountains east of Uitenhage and north of Stormsriver.

O. pictum occurs at an alltitude of 650 -- 1300 m. Flowering takes place during August and September. Nothing more is known about its biology.

The diagnostic features are: Erect 2 m tall shrub; leaflets flat, densely migro-punctate; inflorescence 60 -- 90 flowered, densely spicate; flowers white, each triplet subtended by a broadly ovate bract; standard broadly elliptic; calyx shaggy.

Specimens examined

-3324 (Steytlerville): Baviaanskloof Mountains, between Smitskraal and Wilgehof (-CB), 17-9-1973, *Oliver 4588* (PRE, STE); Winterhoek Mountains (-DB), 15-9-1930, *Fries, Norlindh & Weimarck 1065* (K, PRE, STE); mountain road north of Patensie (DB), 12-7-1954, *Taylor 1285* (PRE, SAAS).

37. Otholobium venustum (Eckl. & Zeyh.) C.H. Stirton in S. Afr. J. Bot. 52: 4 (1986).

Psoralea venusta Eckl. & Zeyh., Enum. 231 (1836); Walp. 1: 658 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 155 (1862); Forbes in Bothalia 3: 134 (1930). Holotype: " Saldanha Bay", *Ecklon & Zeyher* s.n. (S). I have only found a single specimen which bears the printed Eckl. & Zeyh. label.

Semi-prostrate to sprawling shrub up to 1 m tall; branches glabrous, seasonal shoots appressedly pubescent. **Leaves** digitately trifoliolate, petiolate. **Leaflets** 25 -- 35 mm long, 3 -- 4(7) mm wide, narrowly obovate to narrowly oblong, ascending, apex acute, base cuneate, half-conduplicate; pellucid-dotted when fresh, pale yellow when dry, glands numerous, equal, scattered evenly on both surfaces; younger leaves appressedly puberulent on both surfaces, becoming glabrous with age; petiole 2 mm long, petiolule 1 mm long; stipules 3 -- 4 mm long, linear, persistent, longer than the petiole, finely hairy, straight, clasping. **Inflorescences** spicate, terminal on short 10 -- 12 node seasonal shoots, (50)70 -- 90 mm long, comprised of 6 -- 7 triplets of sessile flowers, each triplet subtended by a single, oblong, acuminate, sparsely hairy, glandular, 3 -- 5 mm nerved, 4 -- 5 mm long, 2 mm wide bract; peduncle 30 -- 45 mm long, greatly exceeding the subtending leaves. **Flowers** 9 -- 10(11) mm long, standard mauve to pink, keel and wing petals white, ebracteate. **Calyx teeth** much longer than tube, lanceolate; lobes unequal, carinal lobe longest, 8 mm long, 1,5 -- 2,0 mm wide, other four lobes equal; vexillar lobes fused for 2 mm above the tube; sparsely black-sericeous, glands scarcely visible. **Standard** 9 -- 10 mm long, 5,5 -- 6,0 mm wide, ovate, distinctly auriculate, apex emarginate; claw 2,5 -- 3,0 mm long. **Wing petals** 8 -- 9 mm long, 1,5 mm wide, claw 3 mm long, distinctly auriculate, longer than the keel petals; sculpturing upper central, comprised of 10 -- 14 irregular transcostal lamellae. **Keel petals** 7,0 -- 7,5 mm long, 2 mm wide, claw 3,5 -- 4,0 mm long; shorter than wing petals. **Androecium** 7,0 -- 7,5 mm long,

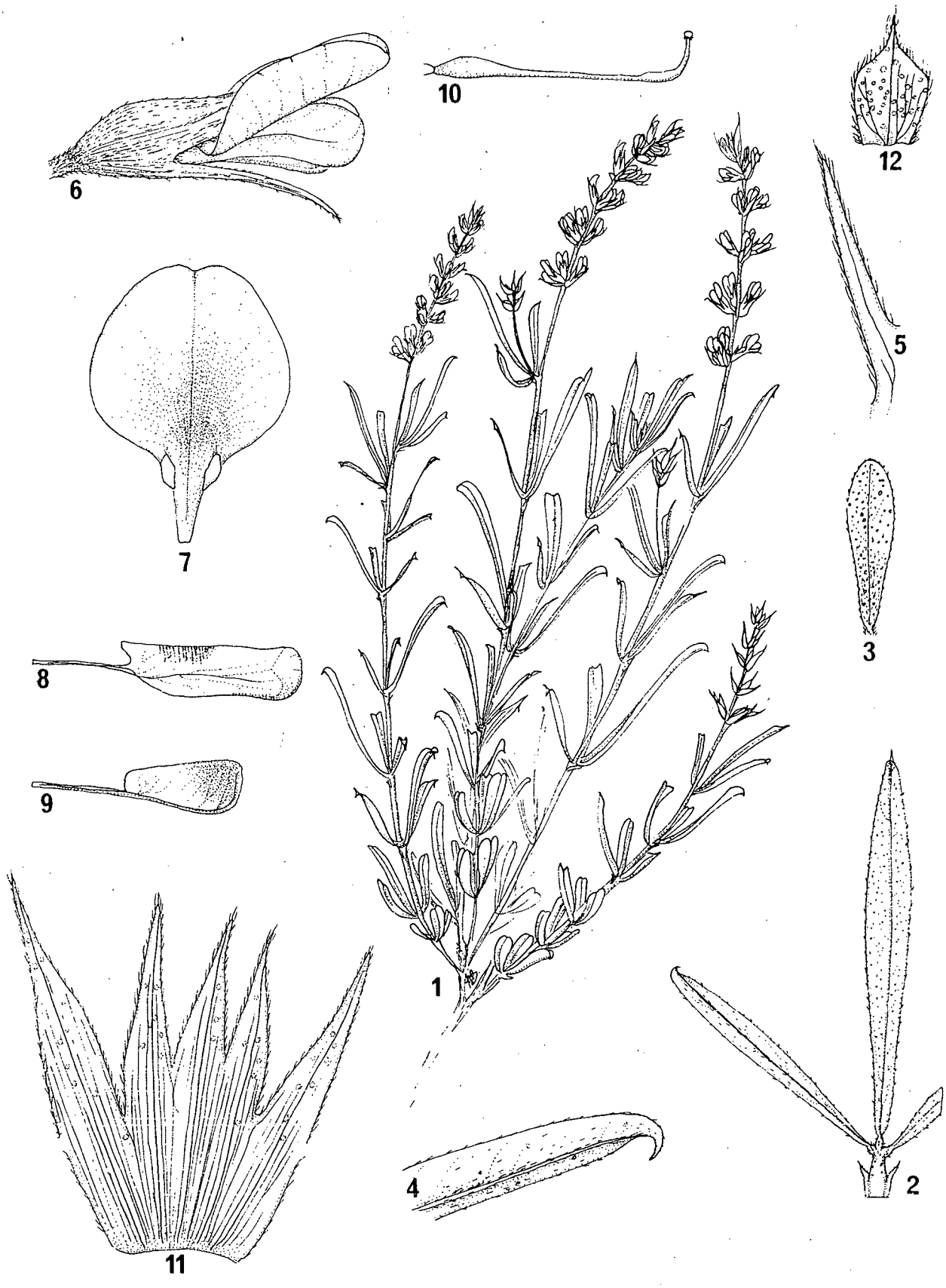


Fig. 9.83 *Otholobium venustum*. 1, Flowering branches, x$^1/_2$; 2, Digitately trifoliolate leaflet, terminal showing upper surface, lateral showing lower surface, x1,5; 3, Terminal leaflet of basal leaves of stem, 1,5; 4, Apex of terminal leaflet, x3; 5, Stipule, x10; 6, Flower, x6; 7, Standard, x5; 8, Wing petal, x6; 9, Keel petal, x5; 10, Pistil, x4; 11, Calyx opened out, inner face, x8,5; 12, Triplet bract, x5 (1, *Acocks 1647*; 2-12, *Nortier Experimental Station* s.n., PRE).

long; ovary 1,5 -- 2,0 mm long, stipitate, glabrous; height of curvature 1,5 mm long, style thickened before point of flexure; stigma penicillate. **Fruit** 8 mm long, 4 mm wide, yellowish brown, glabrous, scarcely reticulate; style persistant. **Seeds** 5 mm long, 3 mm wide, dark chesnut brown, hilum central. Fig. 9.83.

O. venustum is endemic to West Coast Strandveld (Acocks's Veld Type 34), a vegatation of the lower parts of the sandy western coastal plains (Fig. 9.84) and receiving 50 -- 300 mm winter rainfall per annum (Acocks, 1975). It occurs on rocky outcrops at an altitude of 40 -- 60 m in Strandveld proper. Flowering takes place from September to November.

O. venustum is related to *O. candicans* but differs in its terminal 18 -- 21-flowered spicate inflorescences, calyces with teeth slightly longer than the tube and stipitate glabrous ovary. *O candicans* has axillary, 3 -- 9-flowered inflorescences, calyces with teeth 2 -- 3 times longer than the tube, and a subsessile shaggy ovary.

Specimens examined

-3218 (Clanwilliam): Nortier Reserve, Lamberts Bay (--AB), 9-10-1948, *Acocks 15192* (K, PRE); 17-9-1975, *Van Breda 4356* (PRE); 11-9-1964, *Nortier Esperimental Station* s.n. (PRE); Otterdam (--AB), 6-9-1953, *Compton 24196* (NBG); Hills NE of Langebaan, 10-10-1933, *Pillans 6998* (BOL); 22,7 km E of Veldrif (--CD), 18-11-1970, *Acocks 24453* (K).

-3317 (Saldanha): 9 km E of Hoedjies Bay (--BB), 12-10-1933, *Salter 3940* (BOL).

-3318 (Cape Town): Schrywerhoek, Langebaan Peninsula (-AA), 25-11-1975, *Boucher 2942* (STE).

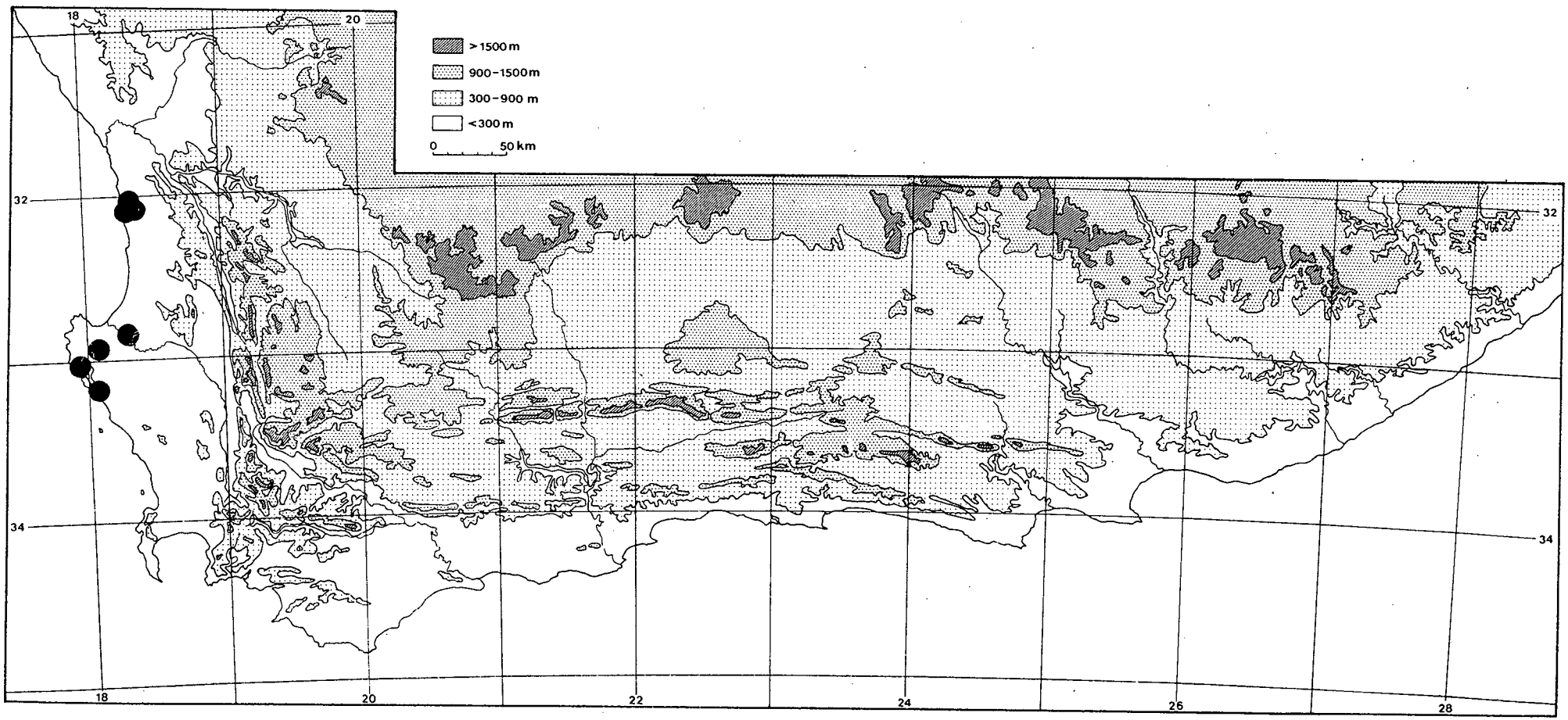


Fig. 9.84 Known distribution of *Otholobium venustum* (Eckl. & Zeyh.) C.H. Stirton in southern Africa.

Without precise locality: Clanwilliam district, 28-9-1915, *Resident Magistrate* s.n. (BOL, NH).

38. Otholobium piliferum C.H. Stirton, *sp. nov., O. bolusii affinis sed foliolis mucrone setoso, lateralibus assymetricis, vexillo elliptico, bractea florali cucullata, floribus albis pallide malvino-suffusis differt.*

Typus: 3227 (Stutterheim): Mount Coke (--CD), 9-1892, *Sim 1507* (K, holo; BOL, NU, PRE, iso)

Planta pyrophyta parva decumbens. Caules numerosi usque 30 cm longi, appresse pubescentes, graciles, striati. Folia digitatim trifoliolata, petiolata, erecta. Foliola inaequalia; terminale 10 -- 13 mm longum, 3 -- 4 mm latum, obovatum; lateralia minora, assymetrica, margine superiore recta, inferiore convexa, ratione 1 : 3; venulis inferne distinctis, apice acuta, basi cuneata, glabrescentia; glandulis impressis superne magis distinctis; petiolus 1 -- 2 mm longus, petioluli 0,75 -- 1,0 mm longi. Stipulae 4 -- 5 mm longae, anguste subulatae superiores late subulatae, ciliate. Inflorescentiae pedunculatae, axillares, in ramulis annuis in duobus tertiis superioribus frequentes, gregem unum triflorum a bractea lutescenti 3 mm longa oblongo-ovata irregulariter dentata truncata subtenta continentes; floribus pedicellatis, pedunculo 4 mm longo. Flores 8 -- 9 mm longi; pedicellis 3 mm longis, albi malvino-suffusi, omnes a bractea 3 mm longa cucullata auguste lanceolata subtenta. Calyx quam corolla longior, 8 -- 10 mm longus; lobus carinalis quam alii longior 6,5 -- 7,0 mm longus, 2,5 -- 3,0 mm latus, acuminatus, quam tubum 3 mm longum triplo longior; dentes vexillares brevissimi, ultra tubum non connati; laterales longitudine intermedii; costae debiles, subtiliter glandulosae pro maxima parte in tubo, margine velutina. Vexillum 9 -- 10 mm longum, 5 mm latum ellipticum. Alae 8 -- 9 mm longae, 2 mm latae. Petala carinae 6 mm longa, 1,5 mm lata. Androecium 6,0 -- 6,5 mm longum, stamen vexillare liberum. Pistillum 5,0 -- 5,5 mm longum; ovarium 1,2 -- 1,5 mm longum, sparsim stipitato-glandulosum, gynophoro 0,4 mm longo; stylus glaber; entasis ad partem flexuosam magis evolutus, parte curvata 1,5 mm alta; stigma penicillatum. Fructus seminaque ignoti.

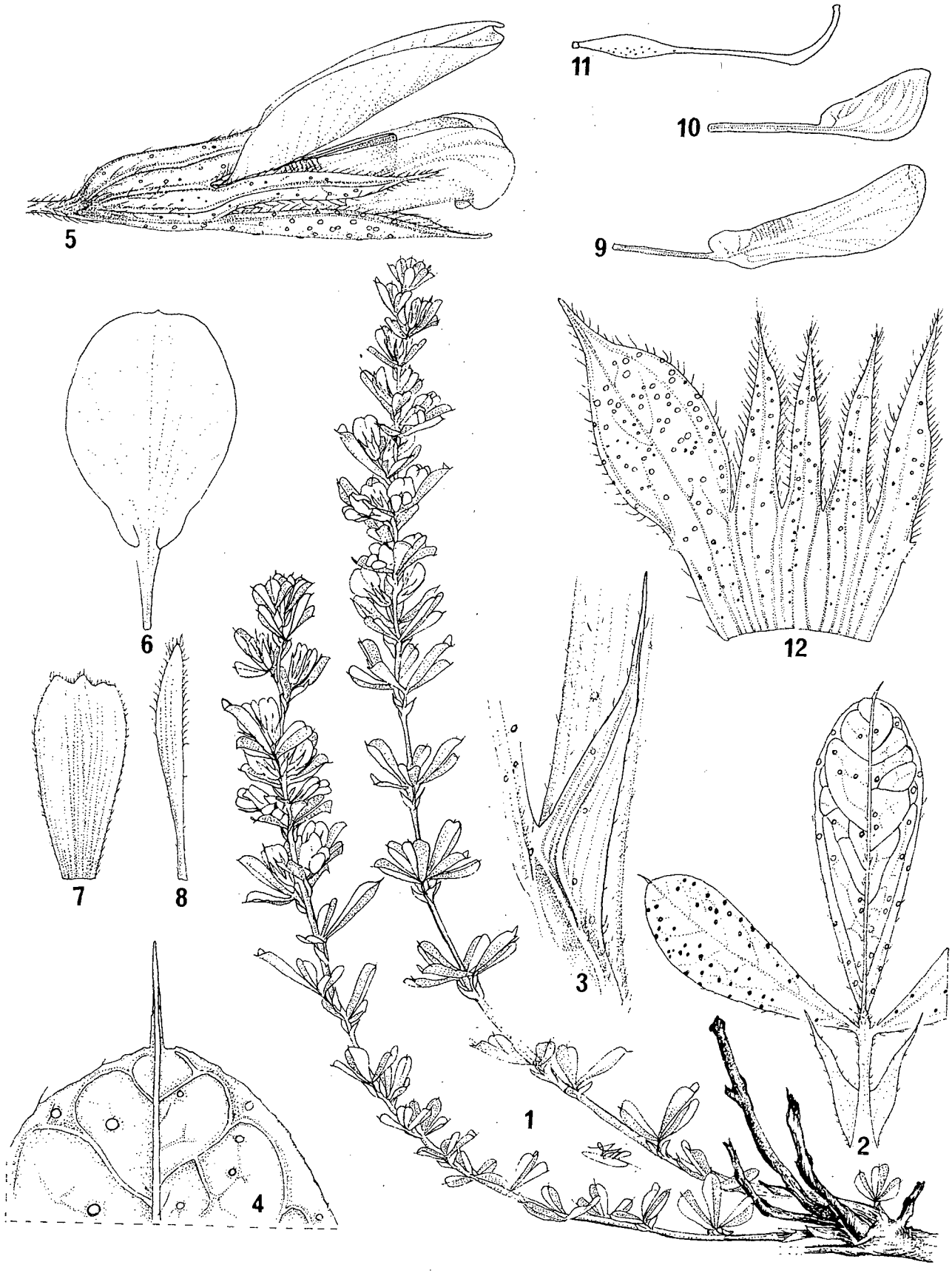


Fig. 9.85 *Otholobium piliferum*. 1, Flowering shoots, x1; 2, Digitately trifoliolate leaflet, terminal showing lower surface, laterals showing upper surfaces, x5; 3, Side view of stipule, x11; 4, Apex of terminal leaflet, x20; 5, Flower, x9; 6, Standard, inner face, x6; 7, Triplet bract, x10; 8, Flower bract, x10; 9, Wing petal, x6; 10, Keel petal, x6; 11, Pistil, x8; 12, Calyx opened out, inner face, x9 (*Sim 1213*).

Small decumbent pyrophyte. **Stems** many, up to 30 cm long, appressed pubescent, slender, striate. **Leaves** digitately trifoliolate, petiolate, erect. **Leaflets** unequal; terminal leaflet 10 -- 13 mm long, 3 -- 4 (5) mm wide, obovate; laterals smaller, assymetrical, upper margin straight, lower convex, ratio 1 : 3; veins distinct below, apex acute, base cuneate, glabrescent; glands impressed, more evident on upper surface; petioles 2 -- 4 mm long, petiolules 0,75 -- 1,00 mm long. **Stipules** 4 -- 5 mm long, narrowly subulate becoming broadly subulate in upper axils, ciliate. **Inflorescences** pedunculate, axillary, common in upper two thirds of seasonal shoots, each comprised of a triplet of pedicellate flowers, each triplet subtended by a yellowish 3 mm long, oblong-obovate, irregularly toothed, truncate bract; peduncle 4 mm long. **Flowers** 8 -- 9 mm long, white suffused with mauve; pedicels 3 mm long, each flower subtended by a 3 mm long, cucullate, narrowly lanceolate bract. **Calyx** longer than the corolla; 8 -- 10 mm long; carinal lobe longest 6,5 -- 7,0 mm long, 2,5 -- 3,0 mm wide, acuminate, three times longer than the 3 mm long tube; vexillar teeth shortest, not fused above the tube, lateral teeth intermediate, ribs weak, finely glandular mostly on the tube, margin of the teeth velutinous. **Standard** 9 -- 10 mm long, 5 mm wide, claw 2 mm long, elliptic, apex obtuse, auriculate. **Wing petals** 8 -- 9 mm long, 2 mm wide, claw 2 -- 3 mm wide; auriculate; sculpturing present, upper basal and upper left central, comprised of up to 10 transcostal lamellae. **Keel petals** 6 mm long, 1,5 mm wide, claw 3 mm long, base curling upwards. **Androecium** 6,0 -- 6,5 mm long, vexillar stamen free. **Pistil** 5,0 -- 5,5 mm long; ovary 1,25 -- 1,5 mm long, sparsely stalked glandular, gynophore 0,4 mm long; style glabrous, entasis developed maximally at point of flexure, height of curvature 1,5 mm long, stigma pencillate. **Fruits** and seeds unknown. Fig. 9.85.

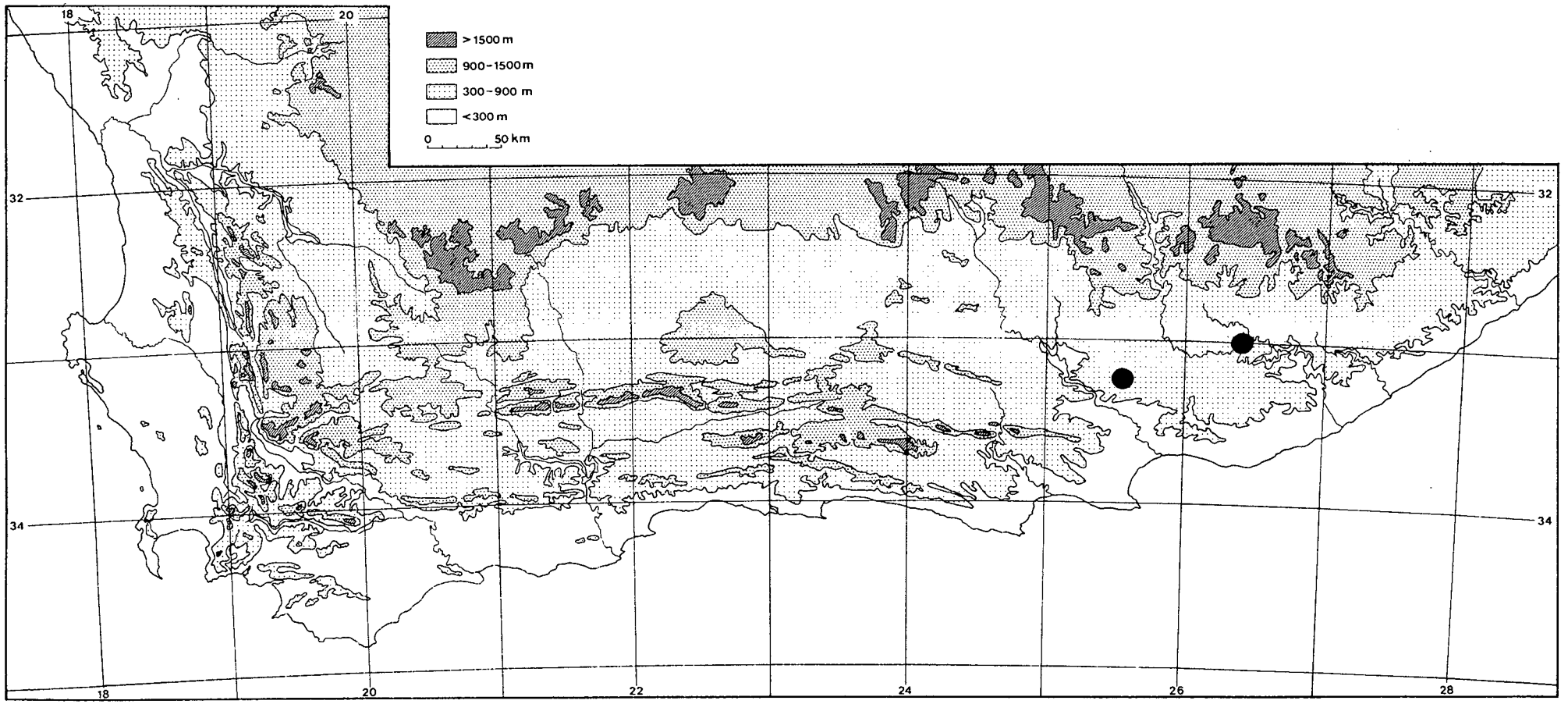


Fig. 9.86 Known distribution of *Otholobium pilifenum* C.H. Stirton in southern Africa.

O. piliferum is one of the rarest species of *Otholobium*. First collected by Sim in 1892 and Bulcock in 1914, it has not been seen for over 70 years. It inhabits False Macchia (VT 70) and Eastern Province Thornveld (VT 7); the latter area probably rather different today than when the first collection was made (Fig. 9.86). Flowering has been recorded in September and January.

This species is easily separated from all other species of *Otholobium* by a combination of its decumbent habit, long hairlike mucro on the leaflets, and narrowly subulate stipules.

Specimens examined

-3326 (Grahamstown): 1-1914, Grahamstown area, *Bulcock* s.n. (GRA).

-3227 (Stutterheim): Mount Coke (--CD), 9-1892, *Sim 1507* (BOL, NU, PRE).

39. Otholobium obliquum (E. Mey.) C.H. Stirton in S. Afr. J. Bot. 52: 3 (1986).

Psoralea obliqua E. Mey. in Linnaea 7: 164 (1832); Comm. 84 (1836); Walp., Repert. 1: 656 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 148 (1862); Forbes in Bothalia 3: 131 (1930). Lectotype: "In montosis rupestribus humidioribus ad montem Paarlberg", *Drège* s.n. (PRE, lecto; BM, G, GBH, L, TCD, W, iso). Syntypes: "Prope Stellenbosch" *Drège* s.n. (K, MO); "Dutoitskloof", *Drège* s.n. (PRE). In the protologue Meyer cited " Hottentots Holland" as the locality. I have not come across any specimens which bear such a legend. Neither is it mentioned in Meyer's later more important work, his Commentario. In this work he lists the above localities. I have concluded therefore that his original citation of Hottentots Holland referred to a general area or was an imprecise locality. I have lectotypified the "Paarlberg" specimen in PRE as it best matches the protologue and is duplicated in a number of herbaria.

An erect much-branched rounded shrub up to 1m tall. **Stems** 5 -- 20, brownish with longitudinal green slits; twigs pubescent. **Leaves** digitately trifoliolate; dark green on overseasonal shoots, yellowish-green on seasonal shoots; erecto-patent, distinctly nigropunctate in dried material. **Stipules** 5 -- 6 mm long, 3 -- 4 mm wide, ovate, senescent, clasping but later recurving, pale greenish yellow, membraneous. **Leaflets** unequal, terminal leaflet symmetrical, obovate, 3 -- 30 mm long, 5 -- 8 (9) mm wide, the laterals shorter, excentric with the upper half 2 mm wide and the lower half 4 -- 5 mm wide; apex aristate-mucronate, base cuneate; densely villous on midvein and along margins in younger leaflets but becoming glabrescent with age; petiole 2 -- 3 mm long; petiolules 1 mm long. **Inflorescences** borne on short 2 mm long peduncles in the upper 3 -- 4 axils of short 60 -- 80 mm long, seasonal shoots, much overtopped by the leaves; comprised of a single triplet of flowers, each triplet subtended by a caducous narrowly oblong 6 -- 7 mm

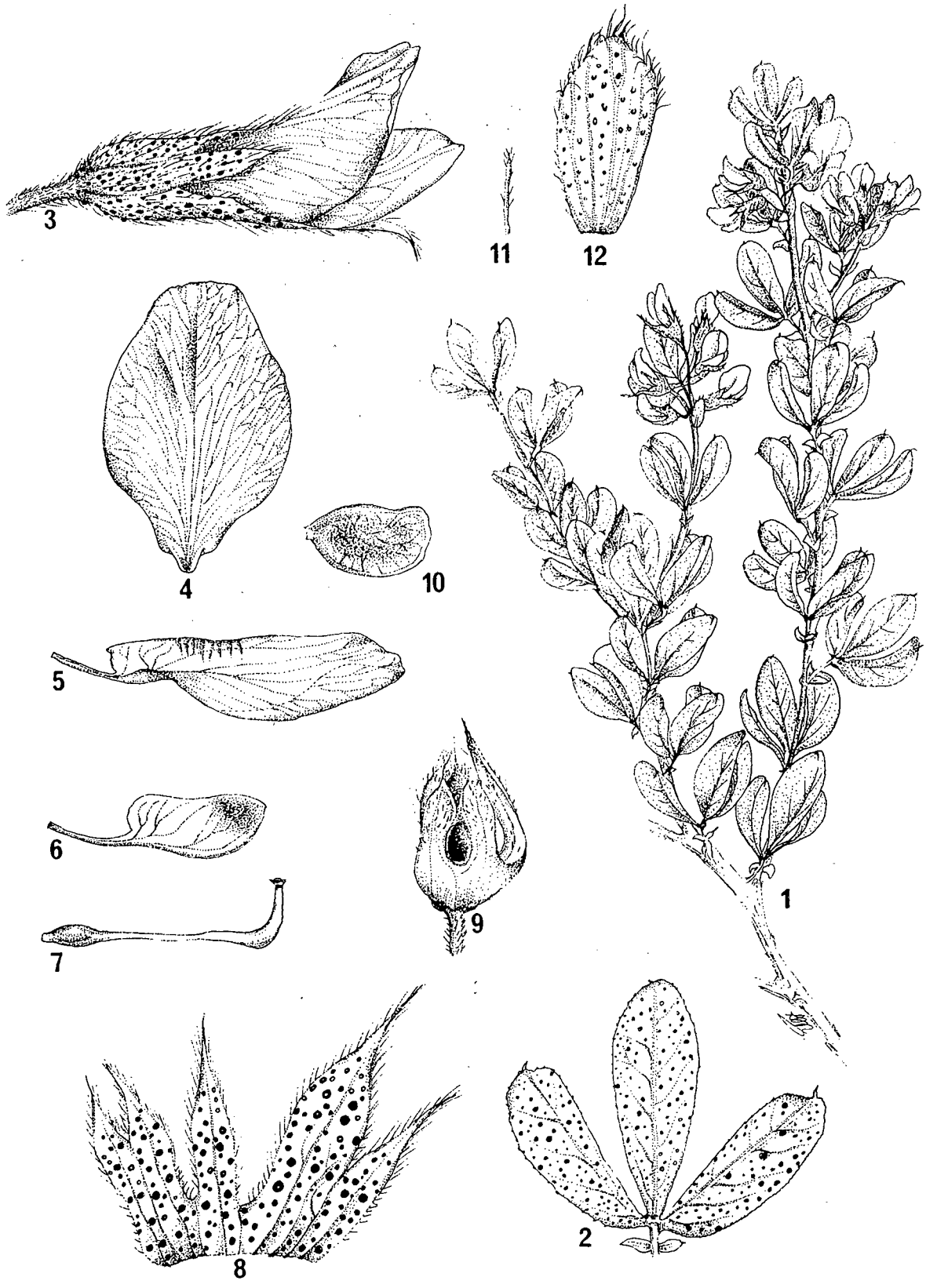


Fig. 9.87 *Otholobium obliquum*. 1, Flowering branches, $x^2/_3$; 2, Digitately trifoliolate leaflet, terminal showing upper surface, laterals showing lower surface, x2,5; 3, Side view of flower, x4,5; 4, Standard, x4; 5, Wing petal, x5; 6, Keel petal, x5; 7, Pistil, x10; 8, Calyx opened out, inner face, x4; 9, Accrescent calyx, x7; 10, Fruit, x7; 11, Flower bract, x5; 12, Triplet bract, x5 (*Garside 245*).

Fig. 9.88 *Otholobium obliquum.* 1, General habit of leaves; 2, Short inflorescences hidden in the axils of erecto-patent leaves. Note the partially upflexed standard and displayed drooping wing petals (*Stirton 9937*).

long, 2,5 -- 4,0 mm wide, glandular, finely pubescent bract. **Flowers** 10 -- 12 mm long, pale mauve; pedicels 4 mm long. **Calyx lobes** 8 -- 11 mm long, tube 2,0 -- 2,5 mm long, teeth unequal, ovate-acuminate, 2 -- 3 times longer than the tube; carinal lobe longest, 9 -- 11 mm long, 2,5 -- 3,5 mm wide, distinctly 3-lobed, lateral lobes 7 mm long, vexillar lobes 5 -- 6 mm long and fused for about half their length above the tube; somewhat villous outside, ciliate, finely pubescent on inner face of the teeth; glands numerous, scattered evenly over surface, greenish yellow in fresh state but drying black; calyx membraneous and distinctively cucullate in fruit. **Standard** 8,5 -- 12,0 mm long, 7 -- 8 mm wide, oblong-ovate, claw 0,75 -- 1,50 mm long, weakly auriculate, appendages absent, apex truncate. **Wing petals** 12 -- 13 mm long, 3,5 -- 4,0 mm wide, claw 2,0 -- 2,5 mm long; narrow, billowy; sculpturing present, upper basal, comprised of up to 12 irregular, variously long, transcostal lamellae. **Keel petals** about half the length of the wing petals, 5 -- 7 mm long, 2 mm wide with 2 -- 3 mm long claw. **Androecium** 5 mm long, vexillar stamen fused to the sheath along the lower third of its length, shorter than the rest; sheath slit adaxially, fenestrate. **Pistil** 5 mm long; ovary 1,5 mm long, glabrous, sparsely glandular; height of curvature 1,5 mm long; upper part of style sloping forwards; stigma penicillate, capitate. **Fruits** 5 mm long, 3 mm wide, finely reticulate, papery. **Seeds** unknown. Fig. 9.87.

Otholobium obliquum tends to favour rocky outcrops along or below ridges in mountainous terrain extending from the disjunct outliers of Paarlberg Mountain and of Gryskop on the Piquetberg to the main block of the Dutoits Kloof, Wemmershoek, Franschoek and Hottentots Holland Mountains in the centre then southwards to Kogelberg (Fig. 9.88). It occurs in Mesic Mountain Fynbos on Table Mountain Sandstone at an altitude of 500 -- 1100 m. Flowering takes place from September to December, with a peak in October.

O. obliquum is closest to *O. mundianum* and *O. nitens*. It differs from these species in its erecto-patent nigropunctate leaves and accrescent fruiting calyx.

Specimens examined

-3218 (Clanwilliam): Gruyskop (--DB), 7-11-1934, *Pillans 7244* (BOL).

-3318 (Cape Town): Paarlberg Mountain (--DB), *Drège* s.n. (G, GBH, PRE, TCD, W); Stellenbosch (--DD), 22-10-1846, *Alexander Prior* s.n. (K); 21-10-1971, *Coppejans 1533* (U); *Duthie* s.n. (BOL); 12-1925, *Gillett* s.n. (BOL); *Harvey 8* (MEL 1542084, TCD); *Drège* s.n. (K, MO, W); Jonkershoek (--DD), 12-10-1813, *Garside 245* (K); 2-12-1935, *Forestry Department* s.n. (STE); 21-10-1974, *Esterhuysen 33652* (BOL); 1-10-1958, *Werdermann & Oberdieck 340* (K, PRE); Swartboskloof (--DD), 29-10-1975, *Kruger 44* PRE, STE); 12-10-1966, *Taylor 6970* (K, PRE, STE); 24-11-1981, *Stirton 9937* (E, PRE); 9-6-1960, *Van der Merwe 22-20* (PRE, STE); 25-10-1960, *Van Der Merwe 23-79* (K, PRE, STE); 29-9-1960, *Van Rensberg 388, 399* (PRE, STE); 13-10-1976, *Van Rensberg 2076* (K, PRE); 7-11-1970, *Werger 1218* (K, PRE, STE); Stellenboschberg (--DD), 8-12-1975, *Haynes 1170* (PRE, STE); *Harvey* s.n. (E); Langrivier Catchment (--DD), 31-10-1975, *Haynes 1134* (STE); 10-1967, *Kerfoot 5070*, 12-1965, *5525*, 10-1967, *6084* (STE); Haalkop (--DD), 28-10-1928, *Gillett 1792* (BOL, STE); near Intake (--DD), 17-10-1925, *Nel 713a* (STE); next to path from "Windy Lookout" to Sosyskloof (--DD), 9-11-1981, *McDonald 767, 773* (K, PRE, STE); Guardian Peak (--DD), 7-10-1945, *Esterhuysen 11974* (BOL); Kleinplaas (--DD), 24-11-1981, *Stirton 9937* (PRE).

-3319 (Worcester): west side of Du Toits Kloof (--CA); 28-10-1951, *Maguire 1121* (BOL); Franschhoek Forestry Station (--CC), 23-9-1935, *Compton 5809* (BOL, PRE); 28-9-1935, *Esterhuysen* s.n. (BOL); 3-10-1942, *Leighton* s.n. (K, BOL); 10-1946, *Stokoe*

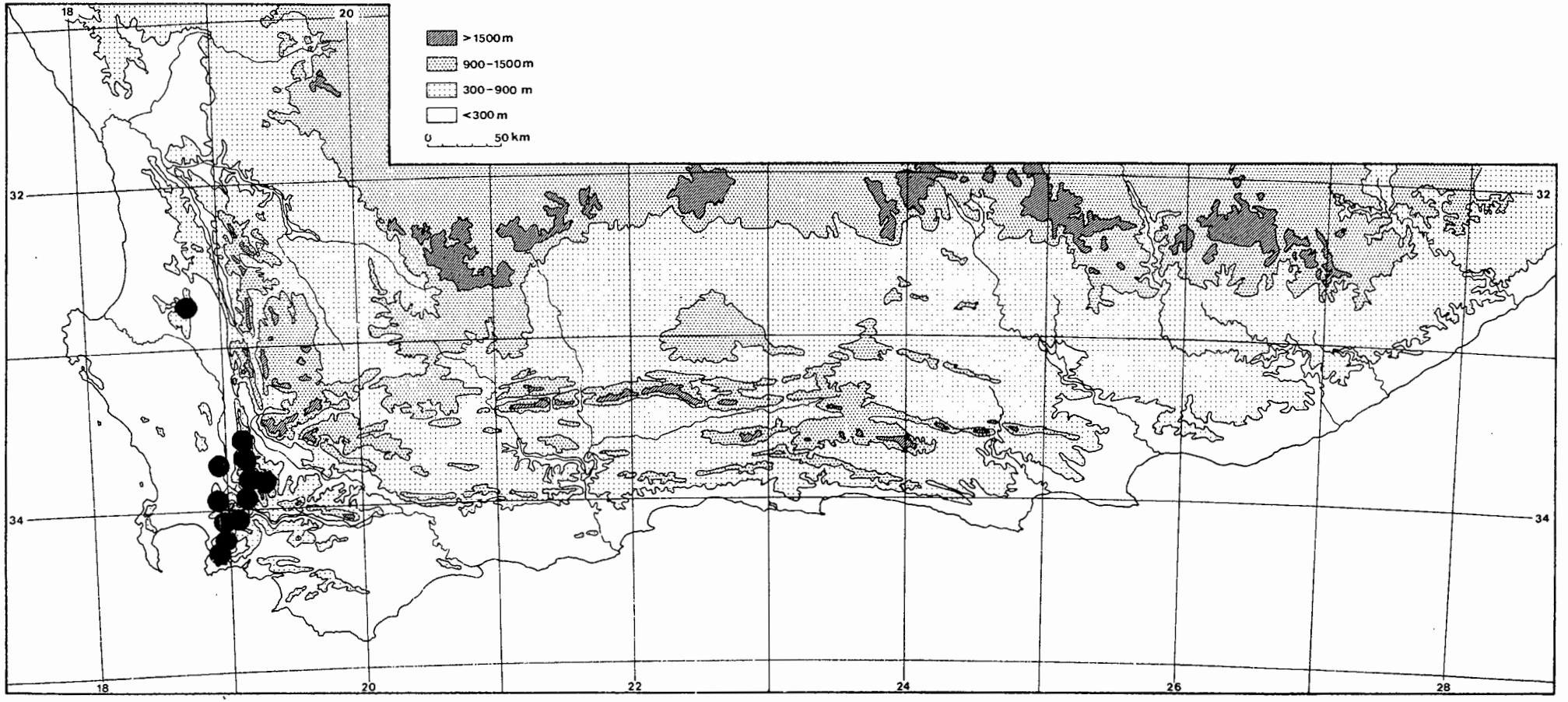


Fig. 9.89 Known distribution of *Otholobium obliquum* (E. Mey.) C.H. Stirton in southern Africa.

s.n. (PRE); Stettynskloof (--CC), 29-10-1950, *Esterhuysen 17651* (BOL); Tierkloof (--CC), 5-11-1950, *Esterhuysen 17712* (BOL); Haelhoek Sneeukop (--CC), 25-12-1943, *Esterhuysen 9584* (BOL); Roesbos Peak (--CC), 14-11-1982, *Esterhuysen 35814* (BOL).

-3418 (Simonstown): Sneeukop, Hottentots Holland (--BB), 7-11-1938, *Stokoe* s.n. (PRE 55435); 1-1888, *Marloth 1842* (PRE, STE); Grietjiesgat (--BB), *Ecklon & Zeyher* s.n. (MEL 1542083); Kogelberg (--BB), 16-12-1946, *Esterhuysen 13325* (BOL); Laurenford (--BB), 7-9-1975, *Esterhuysen 33923* (BOL).

-3419 (Caledon): Palmiet River, Hottentots Holland Mountains (--AA), *Ecklon 1535* (G, W).

Without precise locality: C.B.S., 1847, *Alexander Prior 32* (K); Cape, *Bowie* s.n. (K); between Hottentots Holland and Caledon, *Ecklon & Zeyher* s.n. (MEL 1542082); Attaquaskloof, *Gill* s.n. (K); CBS, *Roxburgh* s.n. (K).

40. Otholobium swartbergense C.H. Stirton in S. Afr. J. Bot. 52: 4 (1986). Type: Swartberg Pass, northern slopes below summit (--CC), *Stirton 10310* (PRE, holo; BOL, K, MO, NBG, NH, STE, iso).

Small spreading, prostrate shrublet to 30 cm tall. **Stems** slender, numerous, covered in short appressed upwardly pointing hairs with longer patent hairs interspersed and dominant on angles. **Leaves** pinnately trifoliolate. **Leaflets** 15 -- 22 mm long, (4) -- 8(11) mm wide (the larger leaves being produced later in the season), flat, entire, elliptic, sericeous but denser below especially along veins; base obtuse, apex mucro arching; laterals assymmetrical, lower half wider, smaller than the terminal leaflet; petioles (3)5 -- 7(9) mm long, hairy, fused to stipules at the base. **Stipules** 5 -- 7 mm long, 1,8 -- 3,0 mm wide, ovate to shortly oblong, apex acute; glabrous inside, sericeous outside. **Inflorescences** pseudoracemose, 6 -- 15 flowered, axillary, hemispherical on long peduncles comprised of 2 -- 4(5) sets of flowers in triplets, lowest set subtended by a persistent 2 --3 toothed flabellate bract; bracts gradually narrowing in remaining sets; filiform bractlets subtending each flower; peduncle (50)90 -- 120(200) mm long. **Flowers** 8 -- 11 mm long, mauve becoming purple with age, enclosed within the calyx at anthesis, but standard reflexing partially; pedicel 1,5 -- 2,0 mm long. **Calyx** 11 -- 13 mm long; lobes unequal, upper four teeth equal, narrowly triangular, curved, 5,5 -- 6,0 mm long, 1,5-- 2,0 mm wide, vexillar teeth fused above tube for about 1/5 their length; keel tooth 9 -- 10 mm long, 3,0 -- 3,5 mm wide, broader then others; veins prominently reticulate; tube 2,5 -- 3,0 mm long. **Standard** 8 -- 10 mm long, 5,0 -- 6,5 mm wide, obovate, slightly reticulate, narrowed towards the 3 mm long claw. **Wing petals** 9,5 -- 10,0 mm long, blade 6 -- 7 mm long, 2,2 -- 2,5 mm wide, longer than the keel petals, auriculate, sculpturing upper basal and left central, comprised of 15 -- 18 irregular parallel lamellae. **Keel blades** 8 mm long, 2 mm wide; apex rounded, blotched purple on inner face. **Androecium** 8 mm long, vexillar stamen 7,5 mm long, loosely attached to the sheath for half its length. **Pistil** 8

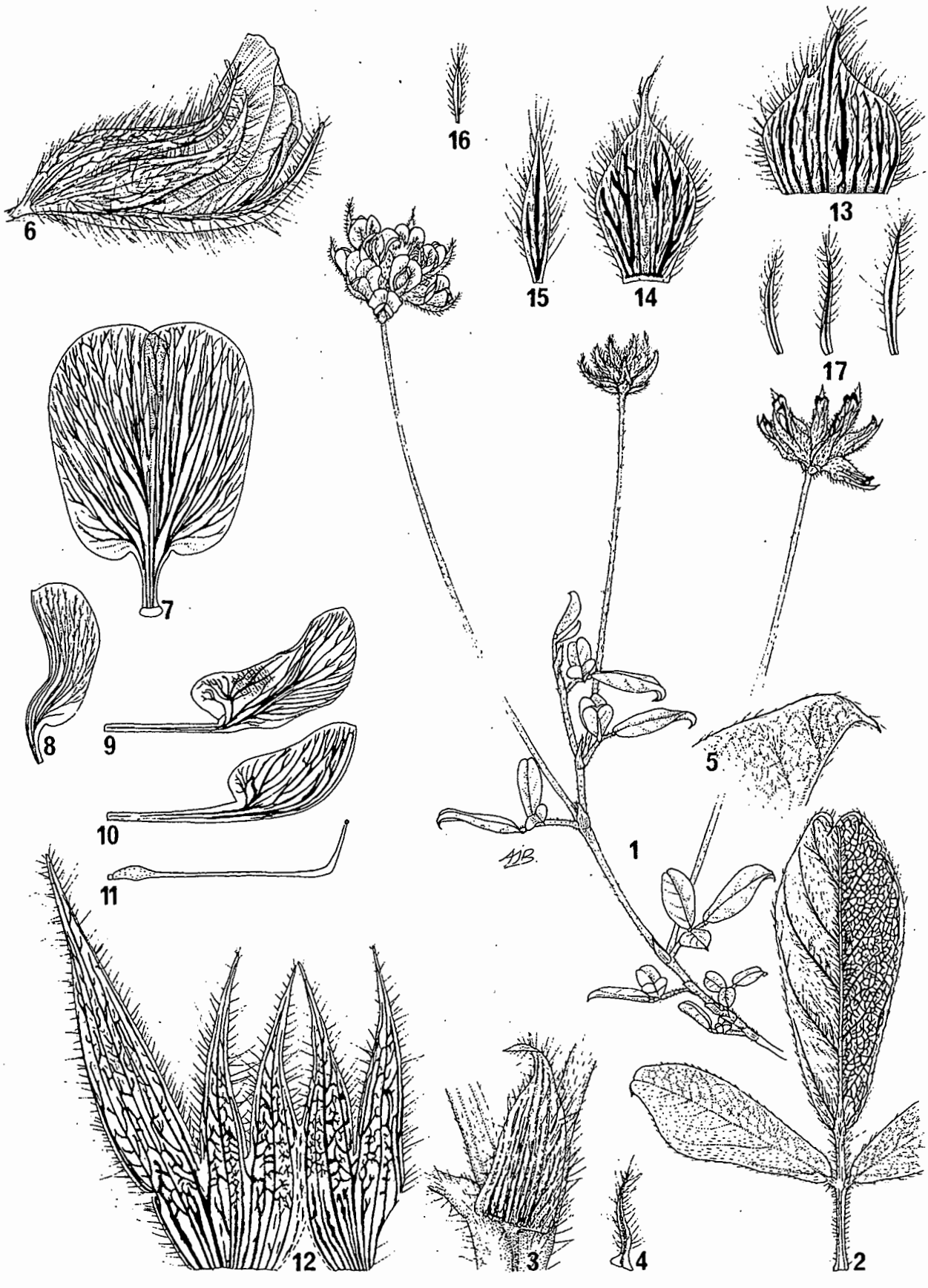


Fig. 9.90 *Otholobium swartbergense*: 1, Flowering shoot, x1. 2, Terminal leaflet, x2. 3, Lateral leaflet, x2. 4, Calyx opened out, x3. 5, Flowering bracts, showing variation from setaceous terminal bract to the lowest positioned flabellate bract, x4. 6, Side view of the flower just prior to opening, x3. 7, Standard, x4. 8, Keel, x4. 9, Wing petal, x4. 10, Androecium, x4. 11, Pistil, x4.

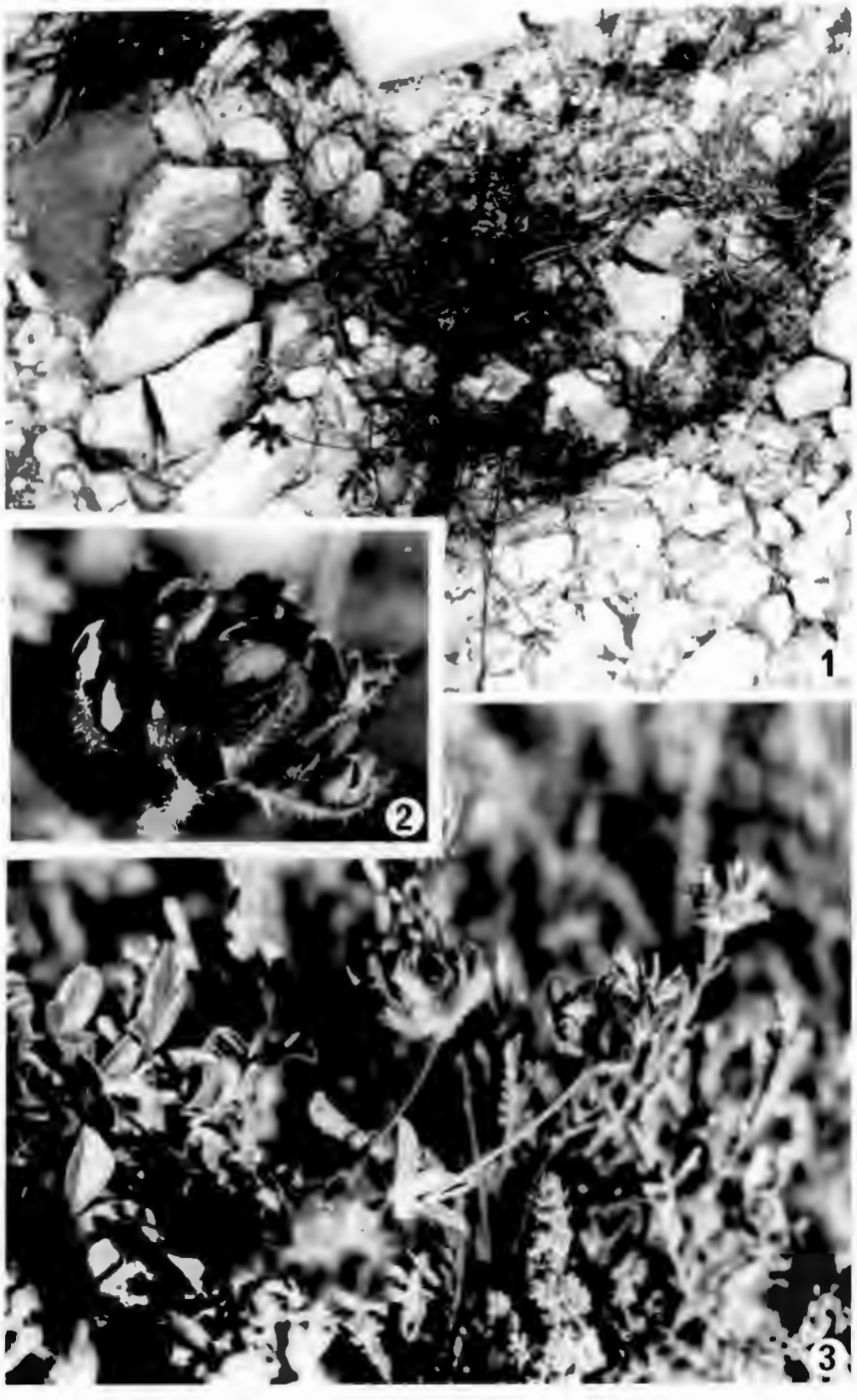


Fig. 9.91 *Otholobium swartbergense*. 1, Sprawling habit of dwarf shrublet; 2, Close up of an inflorescence, all flowers open simultaneously, unlike in *O. sericeum*, its closest relative; 3, Inflorescences held well above the foliage on curved raised peduncles (*Stirton 10310, holotype*).

mm long; ovary 1,5 mm long, sparsely glandular, subsessile; style glabrous, height of curvature 2 mm, entasis broadest at point of flexure, stigma papillose. **Seed** and fruit unknown. Figs. 9.90 & 9.91.

Otholobium swartbergense was first collected by Harry Bolus in 1904. Since then it has been collected about once every decade. It appears to have been missed by many of the collectors who have ritually stopped and lunched at the top of the Swartberg Pass. This is not too surprising as the plant is difficult to find even when it is flowering.

This species has been confused with *O. sericeum* in the herbarium, but when both are seen in the field the differences in habit, size, smell, flower colour, ecological preference and geographical location are decisive. They are undoubtedly related and, as in the species pair *O. fruticans/O. bracteolatum*, illustrate vicariance.

O. swartbergense is a distinctive endemic of the Groot Swartberg Mountains (Fig. 9.92). It flowers during November and December. The plants are recorded by collectors as growing amongst short grass on rocky outcrops or in dry loamy soil. However in 1981 and 1984 the only plants that I could find were growing along the edge of the roadside beneath the crumbling margin of the left hand roadbank as one descends from the top of Swartberg Pass to the Forest Station below.

The species is characterized by a combination of the following features: Small, lax, much branched shrublet; leaflets flat, elliptic; inflorescence hemispherical, 6 -- 15-flowered, lowest triplet subtended by a large 2 -- 3-toothed flabellate bract; flowers mauve becoming purple; calyx lobes unequal, carinal tooth largest, others equal, all with distinctive reticulate network of prominent veins.

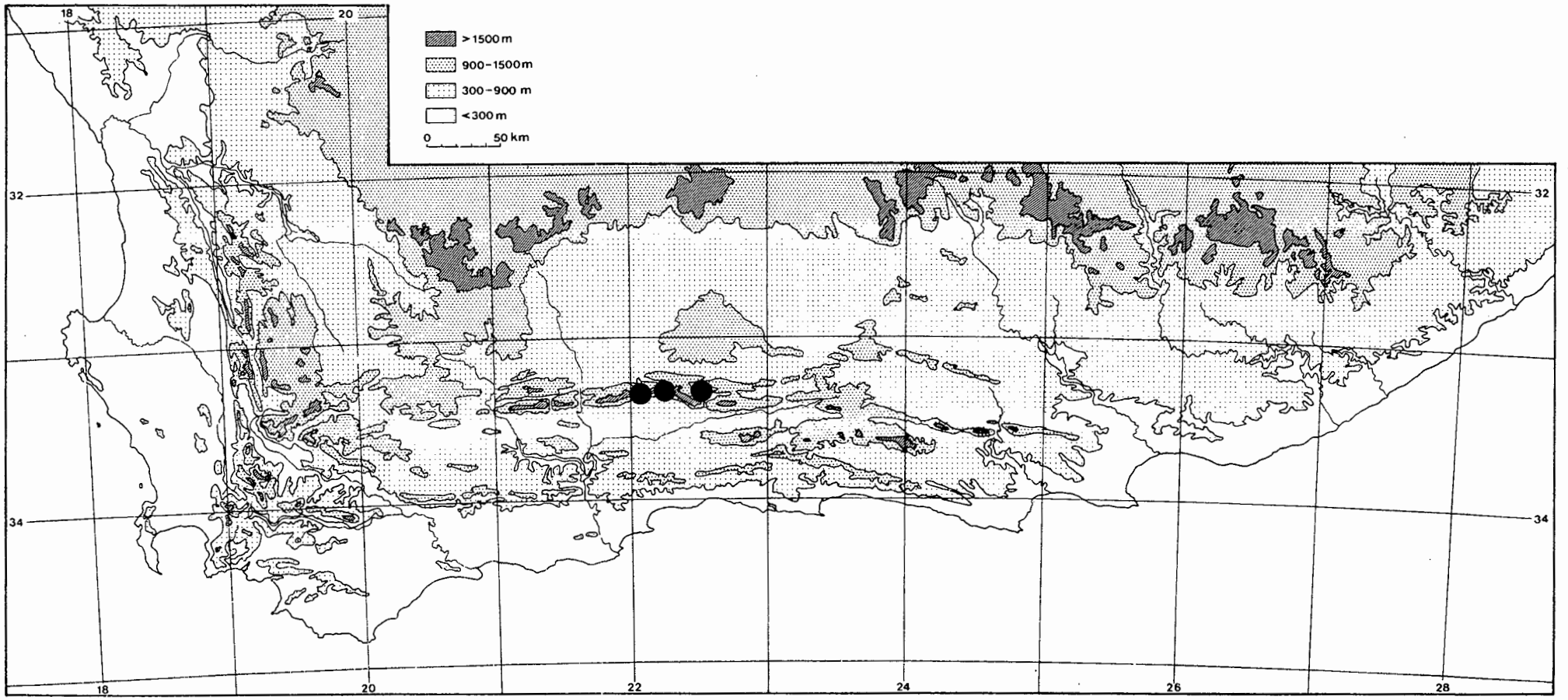


Fig. 9.92 Known distribution of *Otholobium swartbergense* C.H. Stirton in southern Africa.

Specimens examined

-3322 (Oudtshoorn): next to forestry track on Swartberg at Botha's Hoek (--AC), 1-1-1985, *Vlok 888* (K, SAAS); Rus-en-Vrede Falls (--AC), 11-11-1986, *Stirton, Zantovska & Vlok 11563* (K, NBG) northern slopes of Groot Swartberg Mountains (--CC), 12-1904, *Bolus 11476* (BOL, NH, PRE); 1-12-1977, *Bond 1257* (SAAS, STE); 25-1-1941, *Esterhuysen 4563* (BOL); 13-11-1938, *Hafstrom & Acocks 707* (PRE); 12-12-1981; *Stirton 10310* (BOL, K, NBG, NH, PRE, STE); 12-1943, *Stokoe 9025* (BOL); 11-1945, *Stokoe 59576* (SAM); 12-1951, *Stokoe 66078* (PRE, SAM); southern side of Swartberg Pass (--CC), 3-11-1928, *Gillett 2002* (PRE, STE); 19-12-1967, *Grobbelaar 754* (PRE); 2 km below summit on southern side of Swartberg Pass (--CC), 10-11-1971, *Taylor 8286* (STE).

41. Otholobium sericeum (Poir.) C.H. Stirton in S. Afr. J. Bot. 52: 4 (1986).

Psoralea sericea Poir. in Lam. Method. 5: 687 (1804); DC., Prodr. 2: 218 (1825); Meisn. in J. Bot., Lond. 2: 81 (1843); Drège in Linnaea 19: 645 (1846); Presl, Bot. bemerk. 60 (1844); Stirton in Bothalia 13: 317 (1981). Holotype: Without precise locality, *Sonnerat* s.n. (P).

Rhynchodium sericeum Presl, Bot. Bemerk. 60 (1844).

Psoralea tomentosa Thunb., Prodr. 2: 135 (1800) non Cav. (1795); DC., Prodr. 2: 218 (1825); Harv. in Harv. & Sond, Fl. Cap. 2: 156 (1862). The plate of *Psoralea tomentosa* Thunb. published in Courtenay-Latimer, Smith, Bokelman & Batten (1967) belongs here.

P. pedunculata Ker-Gawl in Bot. Register t.223 (1817) non Poir. (1816) nec Vaill. (1891); Meisn. in J. Bot., Lond. 2: 81 (1843).

Eriosema capitatum E. Mey., Comm. 130 (1836); Meisn. in J. Bot., Lond. 2: 81 (1843); Presl, Bot. Bemerk. 60 (1844); Harv. in Harv. & Sond. Fl. Cap. 2: 262 (1862). Lectotype: "Ad fluvium Ruigtervallei in fruticetis", *Drege* s.n. (K, lecto; GBH, OXF, PRE, W, iso)

Rhynchosia cephalotes Steud. Nom. 2,2: 588 (1841).

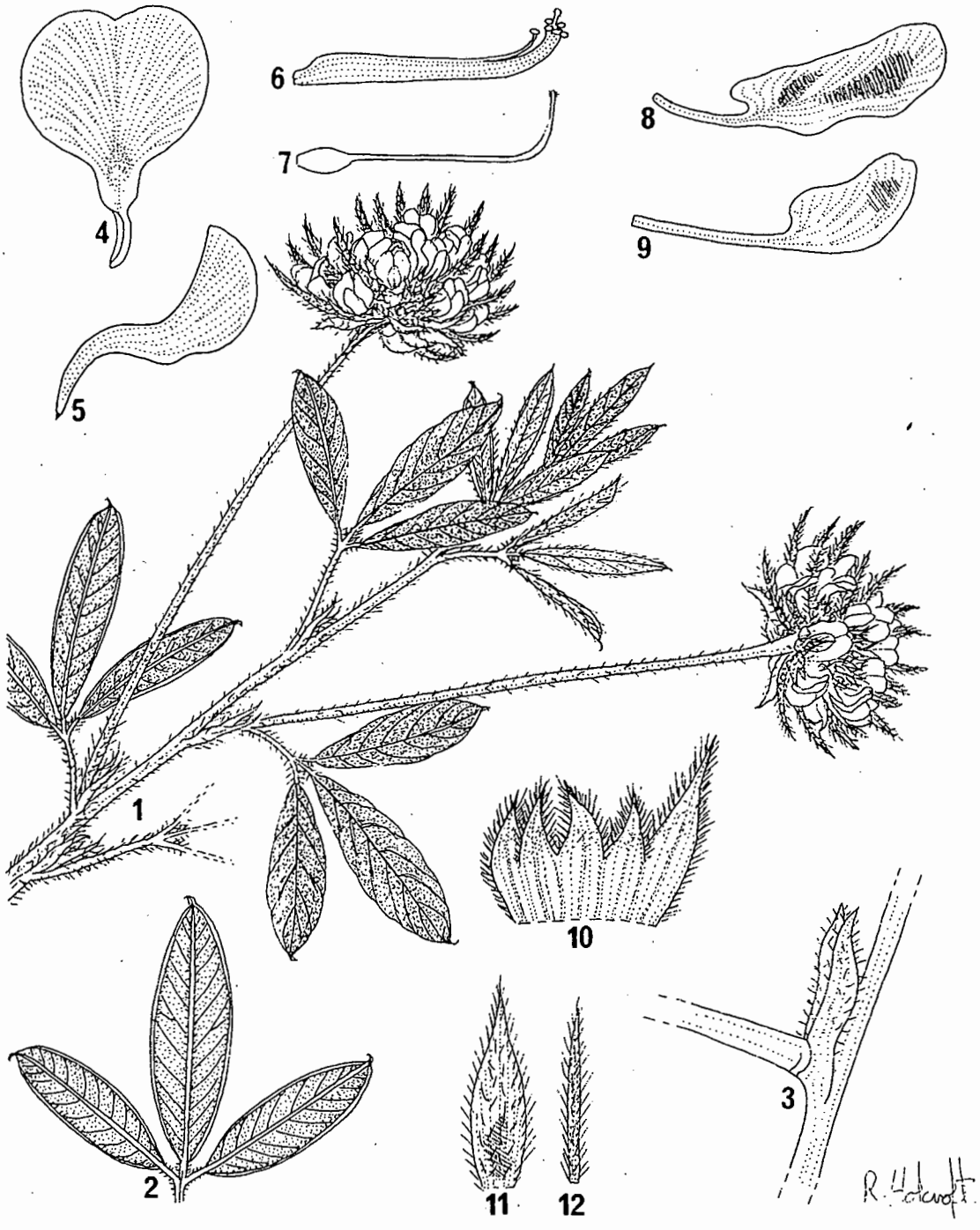


Fig. 9.93 *Otholobium sericeum*. 1, Flowering shoot, x1; 2, Trifoliolate leaflet, x1; 3, Stipules, x3; 4, Standard, x3; 5, Standard, side view, x3; 6, Androecium, x5; 7, Pistil, x5; 8, Wing petals, x4; 9, Keel petals, x4; 10, Calyx opened out, inner face, x2; 11, Triplet bract, x3; 12, Flower bract, x3 (*Britten 2980*).

Erect, scandent, silvery shrubs up to 3 m tall. **Branches** robust, terete, striate, densely cano-pubescent when young, later glabrescent; glands present all over plant but minute. **Leaves** pinnately trifoliolate, scattered, distant, patent, petiolate. **Stipules** 9 -- 15 mm long, 2,5 -- 3,5 mm wide, narrowly lanceolate, upright, appressed to branch but tips arching outwards when older, apex attenuate, equal to or longer than petioles, senescent, densely pubescent outside, glabrous inside. **Leaflets** 25 -- 40 mm long, 9 -- 16 mm wide, laterals smaller, elliptic, dark green glossy and somewhat glabrous above, densely canescent below, apex recurved-mucronate, base rounded, margins inrolled; veins prominent below; rachis 3 -- 4 mm long; petiole (8,0) 9,5 -- 13,0 mm long, distinctly grooved, petiolules 1mm long. **Inflorescences** several, solitary, axillary in uppermost leaves, depressedly hemispherical, 21 -- 35-flowered, congested, 15 -- 20 mm long, comprised of 7 -- 12 triplets of sessile flowers, each set subtended by a 12 -- 14 mm long, 4 mm wide, lanceolate bract, bracts towards the apex being smaller; as the bracts exceed the flowers they give the inflorescence a spiky appearance. **Flowers** 11 -- 12 mm long, 6 mm high, reddish violet; each subtended by a 12 -- 14 mm long linear bract equal in length to the triplet bract. **Calyx teeth** pale green; carinal lobe twice longer than the 4 -- 5 mm long tube, unequal; keel lobe lanceolate, longest, 10 -- 14 mm long, 2,0 -- 3,5 mm wide, laterals and vexillar lobes more or less equal, acuminate; all clothed in long silky black or silvery hairs; vexillar teeth fused slightly above the tube. **Standard** 10 -- 13 mm long, 8 mm wide, claw 3 mm long; obovate, emarginate, auricles and claw prominent, appendages absent; nectar guide white, blade reddish purple with purplish flecks between the upper V formed by the nectar guide. **Wing petals** 9 mm long, 3 mm wide, longer than keel; oblong, tips reddish violet; obtuse, convex, auricle well developed; sculpturing in two areas, upper basal and central, comprised of many parallel backward sloping transcostal lamellae. **Keel petals** 8 -- 10 mm long, 2,5 -- 3,0 mm wide, claw 6 mm long, 4 mm high, apex pale mauve on inner faces. **Androecium** 10 mm long, vexillar stamen lightly joined to sheath, anthers equal, 0,5 mm long. **Pistil** 8 -- 10 mm long; ovary

1,5 -- 2,0 mm long, glabrous except for a few scattered glandular hairs, height of curvature 2 mm long, style before flexure extremely thin, thickened at and above point of flexure; stigma small, penicillate. **Fruits** and seeds unknown. Fig. 9.93.

O. sericeum (Fig. 9.94) grows in seasonally moist areas or nearby water, sometimes forming small thickets. It may also be found along forest margins and in riverine scrub. It occurs at altitudes between 200 -- 600 m. Flowering takes place throughout the year with definite peaks between September and January.

O. sericeum was until recently circumscribed to include *O. swartbergense* (Stirton, 1986). For differences between the two species refer to *O. swartbergense*.

This species is characterized by the combination of the following features: Scandent shrubs up to 3 m tall, with broad, elliptical, 9 -- 16 mm long leaflets, glossy, dark green, and somewhat glabrous above; 21 -- 35-flowered with flowers borne in the upper axils of seasonal shoots in depressedly hemispherical inflorescences.

Specimens examined

-3321 (Ladismith): Albertinia (--BA), *Muir 874* (SAM); Touws River (--CA), 22-12-1949, *Martin 15* (NBG).

-3322 (Oudtshoorn): Outeniqua Mountains near Ruitersbosch (--CC), 10-1905, *Bolus 11795* (BOL, PRE); Outeniqua Mountains (--CC), 1-1839, *Krauss* s.n. (G, TUB, W); George (--CD), 2-11-1894, *Schlechter 3351* (PRE); 1-11-1894, *Schlechter 5771* (BOL, G, PRE, U, Z); 18-8-1847, *Alexander Prior* s.n. (K); Malzaten River near George (--CD), 9-1880, *Young 5516* (BOL, K); Woodville Forest Reserve near George (--DC), 10-1921,

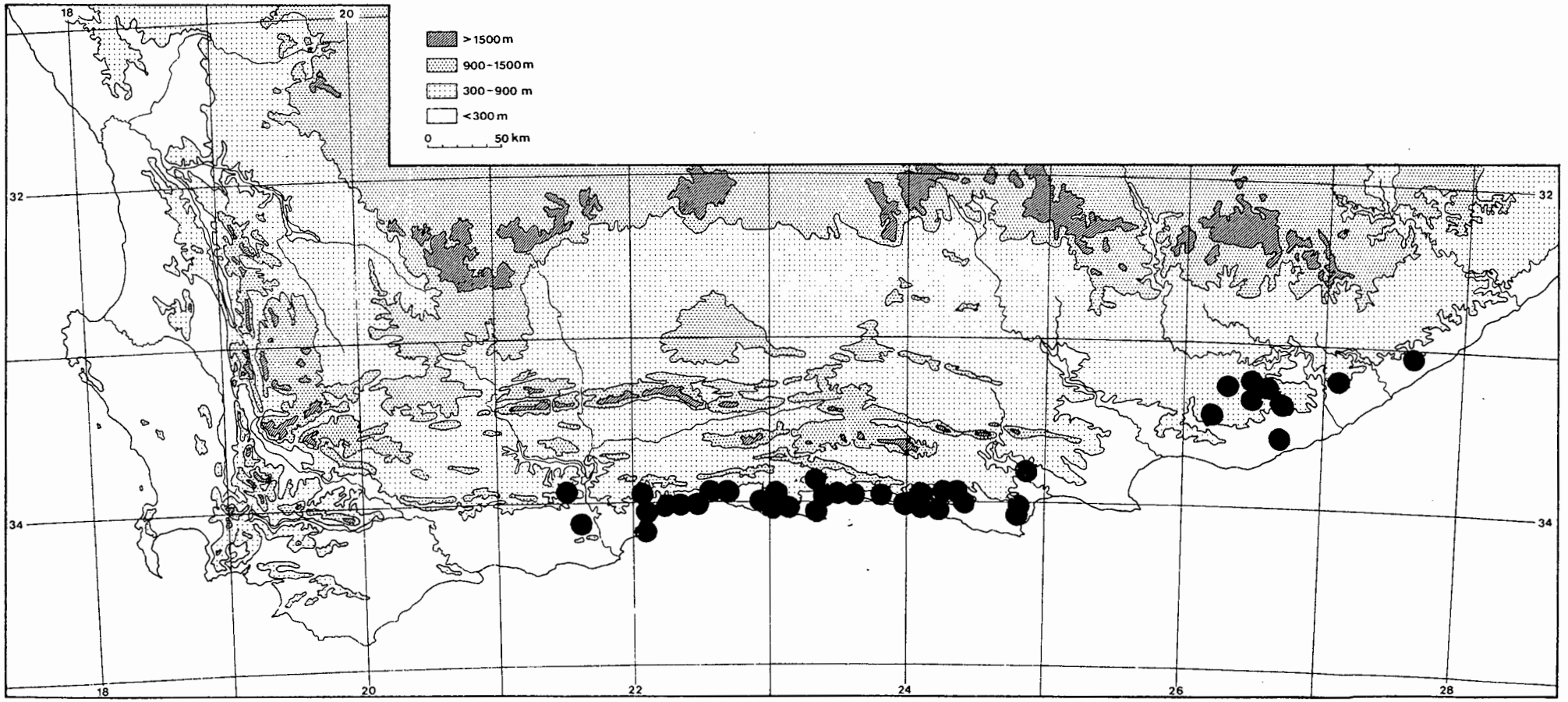


Fig. 9.94 Known distribution of *Otholobium sericeum* (Poir.) C.H. Stirton in southern Africa.

Burton 1365 (SAAS); Ebb and Flow, Wilderness (--DC), 6-2-1944, *Compton 15579* (NBG); Wilderness (--DC), 22-8-1944, *Compton 15813* (NBG); Hills near Berg Plaats settlement (--DC), 9-1936, *Fourcade 5260* (BOL); East of George (--DC), 6-11-1928, *Gillett 2124* (STE); Kleinplaat Forest Reserve, Ertjiesrand (--DC), 30-10-1953, *Taylor 1002* (NBG, SAAS); Groenkop (--DC), 19-1-1976, *van Daalen 7* (STE); Georgetown (--DC), *Zeyher* s.n. (SAM 15424); 1-12-1894, *Penther 2675* (W).

-3323 (Willowmore): Portland Heights (--CC), 8-1888, *Tyson 3007* (SAM); 8-1942, *Fourcade 5713* (BOL); Prince Alfred Pass (--CC), 30-1-1979, *Grobbelaar 2284* (PRU); Witte Els Bosch (--CD), 9-1920, *Fourcade 899* (K); Nature's Valley (--CD), 20-12-1967, *Clarke 664* (PRE, PRU); 3-10-1981, *Stirton 9629* (K, PRE); 1-6-1970, *Taylor 7728a* (STE); Saasveld, Swartrivier (--DC), 3-1-1967, *Morze 2118* (SAAS); between Keurbooms River and Storms River (--DD), 15-10-1938, *Gillett 4583* (BOL, K, PRE); Kromrivier (--DD), *Ecklon & Zeyher 1541* (SAM).

-3324 (Steytlerville): 15 km north west of Kareedouw (--CC), 18-11-1958, *Acocks 20039* (K, PRE); botton of Suuranys Pass (--CC), 1-10-1984, *Stirton 10928* (K); Assegaaibosch (--CD), 12-11-1941, *Esterhuysen 6728* (BOL); Farm Rosslyn, Blaaukranz (--DC), 5-12-1972, *Bayliss 5320* (MO).

-3326 (Grahamstown): between Atherstone and Highlands (--AD), 5-11-1945, *Acocks 12108* (K, PRE); Howieson's Poort (--BC), 30-10-1922, *Britten 2980* (GRA, PRE, STE); 5-1899, *Flanagan 2894* (PRE); Featherstone's Kloof, near Grahamstown (--BC), 9-1868, *Bolus 1939* (BOL); Kariega River (--DA), *Macowan* s.n. (GRA, K, PRE, SAM, TCD); *Ecklon & Zeyher* s.n. (MEL); *Macowan 135* (NH); Blaauwkrantz (--DA), 4-11-1952, *Middlemost 1795* (NBG); near Rietfontein, between Knysna and Port Alfred (--DB), 3-9-1813, *Burchell 3963* (K, W); near Port Alfred (--DB), 9-10-1813, *Burchell 4006* (K).

-3327 (Peddie): at Kaffir Drift Military Post (--AC), 22-9-1813, *Burchell 3775* (K, W); Kleinmonde (--CA), 4-1895, *White 946a* (GRA).

-3421 (Riversdale): between Zuur Vlakte and Portland (--BB), 8-1888, *Tyson 973* (BOL, G, SAM).

-3422 (Mossel Bay): between Little Brak River and Hartenbosch (--AA), 10-10-1814, *Burchell 6193* (K); Great Brak River (--AA), 8-1931, *Thorne* s.n. (SAM 51658); Pacaltsdorp near George (--AB), 5-11-1928, *Hutchinson 1243* (K); Dwarsweg (-AB), 4-10-1981, *Stirton 9685* (PRE); Headland east of Glentana (--AB), 23-9-1982, *Taylor 10491* (STE); Road to Phantom Pass (--BB), 4-10-1981, *Stirton 9669* (PRE).

-3423 (Knysna): Ruigte Vlei (--AA), 10-1921, *Keet 856* (PRE, STE); Blaauwkrantz (--AA), 9-1926, *Phillips 1101* (SAAS); Knysna (--AA), 3-1902, Anonymous s.n. (STE 13609); 3-1921, *Breyer 23705* (PRE); near banks of Knysna River (--AA), 11-1-1920, *Duthie 517* (GRA, STE); Knysna Village (--AA), 10-1922, *Keet 1025* (GRA, PRE, STE); Knysna (--AA), *Marloth s.n.* (PRE 55387); *Pappe* s.n. (K); *Zeyher* s.n. (SAM 15423, W); Phantom Pass (--AA), 12-12-1937, *Wall* s.n. (MO); The Heads (--AA), *Williamson 134* (GRA, PRE); Plettenberg Bay (--AB), 9-1921, *Smart 22817* (PRE); 11-1923, *Smart 26755* (K); 8-1922, *Smart 27061* (PRE); 11-1923, *Rogers 26715* (BOL, GRA, K, SAM, STE); Storms River mouth (--BB), 16-10-1964, *Munro* s.n. (PRE); 29-1-1966, *Liebenberg 7828* (GRA, K, PRE); 6-10-1957, *Theron 2215* (K, PRE).

-3424 (Humansdorp): Tzitsikamma Sea Coast Park (--AA), 30-1-1982, *Venter 8652* (PRE); 10-1-1976, *Spitzenberger* s.n. (W); Humansdorp (--BB), 3-1966, *Bokelman PL38 N.2* (PRE); 11-9-1897, *Galpin 3958* (GRA, PRE); 21-10-1927, *Holland 1675* (BOL); 1-8-1912, *Rogers 2910* (GRA, SAM); *West 247* (BOL).

Without precise locality: Thurfield, Lower Albany, *Atherstone* s.n. (GBH); Albany, *Bowker* s.n. (TCD); *Drge* s.n. (G, GBH, K, OXF, PRE 9340); Ratels Bosch sea slopes, *Fourcade 69* (BOL, GRA); between George and Knysna, 27-10-1933, *Herre 19027* (STE); slopes above Glentana, 21-9-1959, *Lewis 5585* (NBG); Langeberg, near Welgevonden, 10-1912, *Muir 774a* (PRE); Carls Rust Highlands, 2-1917, *Paterson* s.n. (GRA); Touw River, Knysna Lakes Road, 13-9-1953, *Taylor 4101* (NBG, STE); S. Africa, *Williamson* s.n. (TCD); east of Groot River, 23-8-1961, *Wurst 2116* (NBG).

42. Otholobium argenteum (Thunb.) C.H. Stirton in S. Afr. J. Bot. 52: 2 (1986).

Psoralea argentea Thunb., Prodr. 136 (1800); Fl. Cap. 608 (1823). DC., Prodr. 2: 218 (1825); E. Mey., Comm. 87 (1836); Harv. in Harv. & Sond., Fl. Cap. 2: 153 (1862); Forbes in Bothalia 3: 129 (1930). Holotype: "e Cap. Bon. Spei", *Thunberg* s.n. (UPS - Thunb. 17559, seen on microfische).

P. albicans Eckl. & Zeyh., Enum. 231 (1836); Walpers, Repert. 1: 657 (1842). Lectotype: "Inter frutices (Altit. II) laterum montium prope Olifantsrivier (Clanwilliam)", *Zeyher* s.n. (S, lecto; TCD, S, SAM, iso). The isolectotype from S comprises a mixed gathering: the single left hand twig is *O. arborescens* C. H. Stirton.

P. striata Thunb. var. *gracilis* Harv. in Harv. & Sond., Fl. Cap. 2: 153 (1862).

Slender woody shrublet up to 1 m tall, much branched from the base. **Branches** reddish brown, glabrescent, with flattened pustules, densely pubescent on young shoots. **Leaves** digitately trifoliolate, petiolate. **Leaflets** 7 -- 9(10) mm long, 5 -- 6 mm wide, obovate, mucronate, mucro < 0,3 mm long; arching to recurved, base cuneate, conduplicate, densely canescent above and below, margin entire; petiole 3 -- 5 mm long, persistent once leaves have abscised; petiolules 0,5 mm long, sericeous. **Stipules** 1,5 -- 2,0 mm long, subulate, persistent, clasping, densely hairy, glandular at base. **Inflorescences** solitary, subtended by uppermost axil of short up to 12 cm long shoots; comprised of 3 -- 4 triplets of pedicellate flowers; each triplet subtended by a persistent 1 -- 2 mm long broadly ovate, acuminate, glandular bract. **Flowers** 7,0 -- 7,5 mm long, ebracteate; pedicels 1,0 -- 1,5 mm long. **Calyx teeth** shorter than the tube, equal, falcate, carinal lobe somewhat broader than the other lobes, 5,0 -- 5,5 mm long, 0,6 -- 0,8 mm wide, vexillar lobes fused for more than half their length; sericeous, silvery; teeth and tube with the

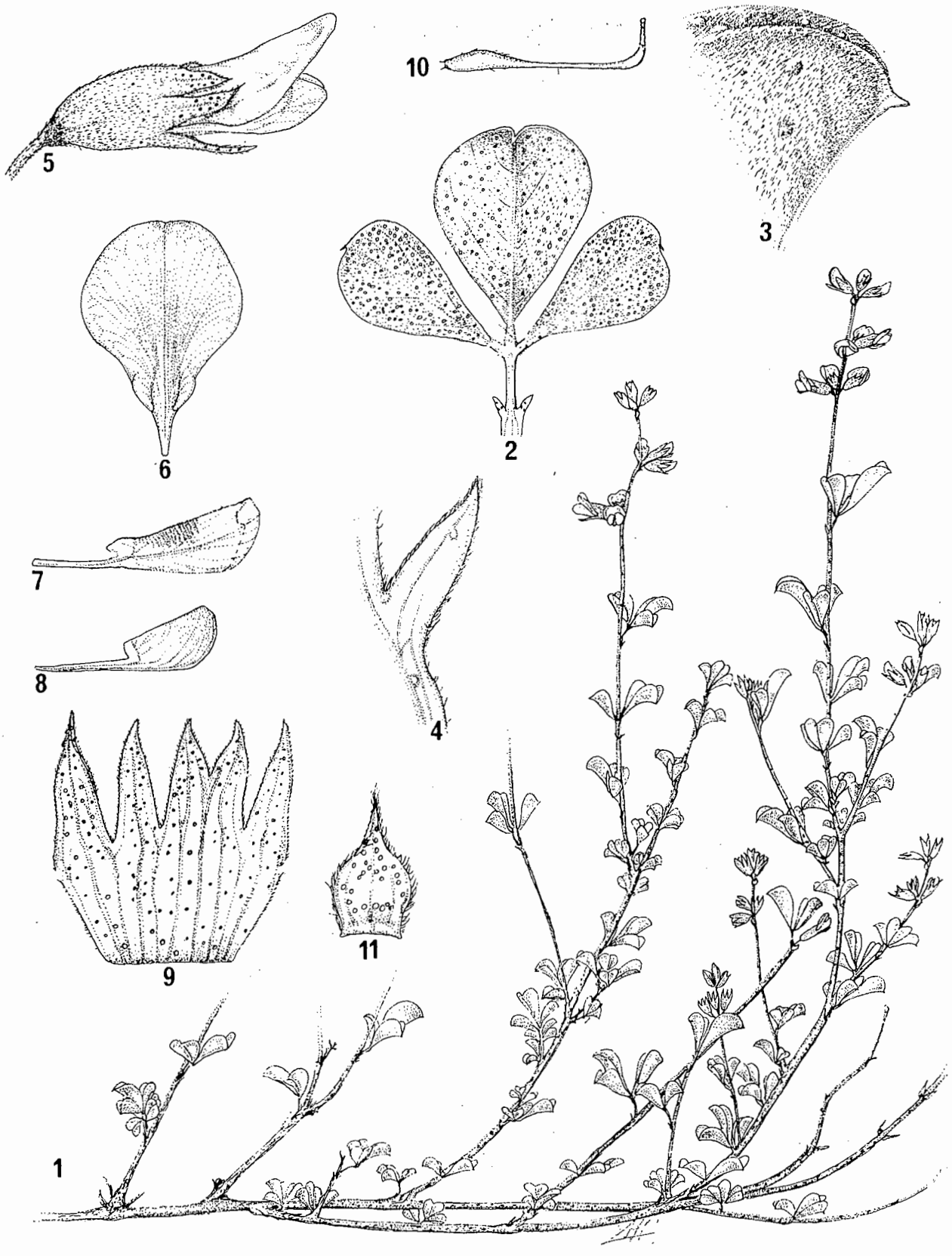


Fig. 9.95 *Otholobium argenteum*. 1, Flowering shoots, x1; 2, Leaflet, terminal showing lower surface, laterals upper surfaces, x4; 3, Apex of terminal leaflet, x10; 4, Stipule, x18; 5, Side view of flower just after anthesis, x6; 6, Standard, inner face, x5; 7, Wing petal, x5; 8, Keel petal, x5; 9, Calyx opened out, inner face, x8; 10, Pistil, x6; 11, Triplet bract, x11 (*Drège* s.n., K).

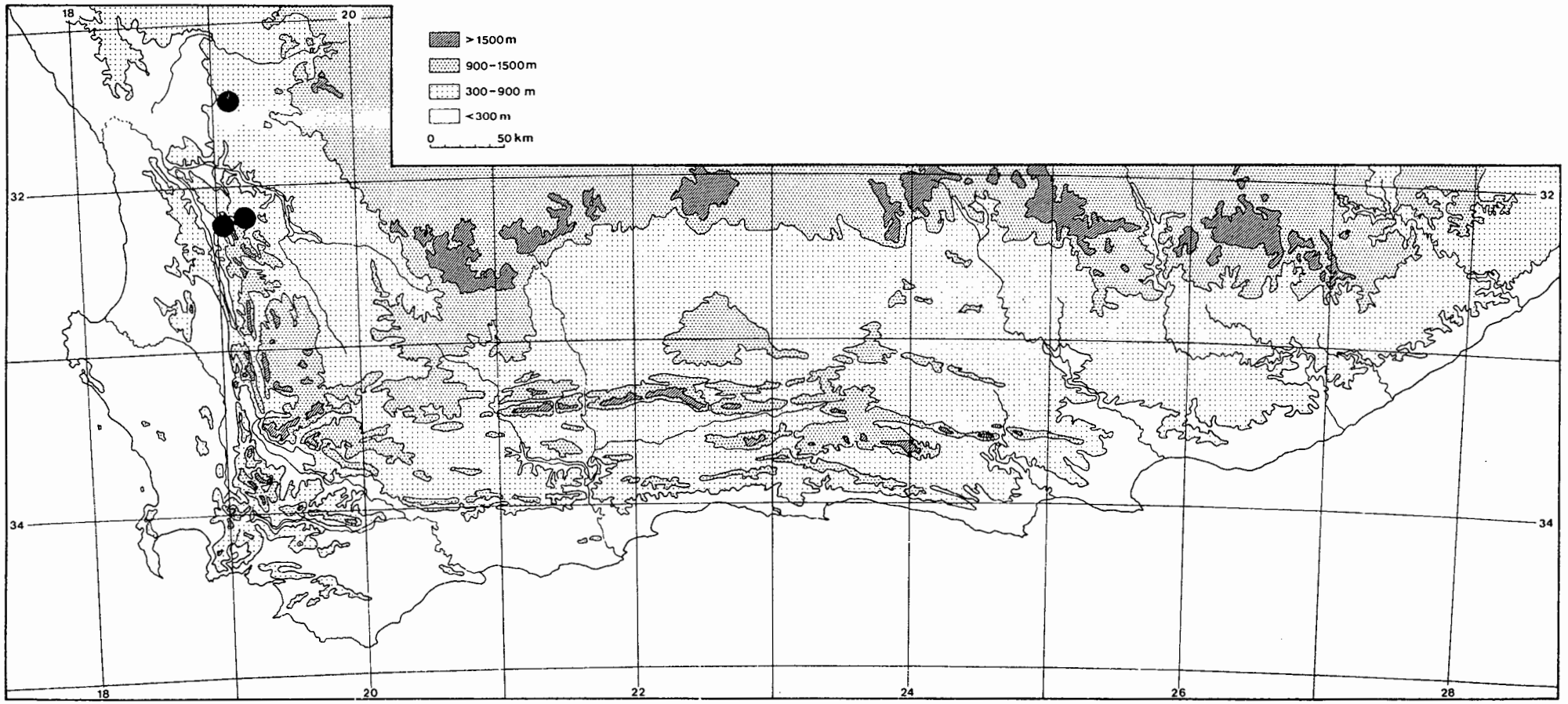


Fig. 9.96 Known distribution of *Otholobium argenteum* (Thunb.) C.H. Stirton in southern Africa.

same number of equally sized glands. **Standard** 7,0 -- 7,5 mm long, 4,0 -- 4,5 mm wide, claw 1,5 mm long; broadly elliptic, apex emarginate, scarcely auriculate. **Wing petals** 7,5 -- 8,0 mm long, 3 mm wide, claw 3 mm long; much longer than the petals, auriculate; sculpturing present, upper central, comprised of 20 -- 25 distinct transcostal lamellae. **Keel petals** 6 -- 7 mm long, 2,5 mm wide, claw 4 mm long. **Androecium** 7 mm long, pseudomonadelphous, vexillar stamen fused to the sheath for half its length, fenestrate. **Pistil** 6,0 mm long; ovary 1,5 mm long, densely sericeous; height of curvature 1,5 mm long, style entasis broadest before curvature, stigma penicillate. **Fruits** and **seeds** unknown. Fig. 9.95.

This species is one of the rarest species of *Otholobium* and has not been collected for over a century (Fig. 9.96). I failed to find it on three different trips to the *Drège* localities.

Specimens examined

-3019 (Loeriesfontein): between Pedroskloof and Leliefontein (--AA), *Drège* s.n. (G, K, MO, TCD, W).

-3218 (Clanwilliam): in mountains near Olifantsrivier (--CA), *Zeyher* s.n. (SAM, S, TCD).

Without precise locality: Krakeelkraal, *Drège* s.n.; *Bueck* s,n. (L 301280); *Thunberg* s.n. (UPS 17559).

43. Otholobium zeyheri (Harv.) C.H. Stirton in S. Afr. J. Bot. 52: 4 (1986).

Psoralea zeyheri Harv., Thes. Cap. 1: 15, t.80 (1859); Harv. in Harv. & Sond., Fl. Cap. 2: 156 (1862); Forbes in Bothalia 3: 132 (1930). Holotype: Twenty-four Rivers, *Zeyher 2375* (K, holo; G, K, PRE, S, SAM, TCD, W, iso).

Suffrutex up to 40 cm high, coppicing after fire. **Stems** 13 -- 18 cm long, branching at the base, ascending, pubescent, subterete, rigid. **Leaves** digitately trifoliolate, held erect, dimorphic. **Leaflets** unequal, terminal leaflet of lower leaves 35 -- 40 mm long, 15 -- 20 mm wide, elliptic or obovate; laterals smaller, symmetrical, upper leaves much narower, base cuneate to rounded, all mucronulate, impunctate, margin scaberulous; young leaves villous, glabrescent; rachis 1 -- 3 mm long, petiolules 1 mm long, petioles 10 -- 20 mm long. **Stipules** 8 --13 mm long, variable, usually lanceolate-subulate, acute, striate, margins hairy. **Inflorescences** spicate, axillary in upper node, pyramidal, expanding up to 50 cm long with age, oblong, comprised of 25 -- 30 triplets of sessile flowers each set subtended by a purple tinged, 6 -- 7 mm long, 2 -- 3 mm wide, ovate, acute bract; bracts become smaller towards the apex of the inflorescence, peduncle up to 25 cm long, over 5x longer than the leaves. **Flowers** pure white, pale lilac or deep pink, 9 -- 10 mm long. **Calyx** teeth longer than the tube, teeth unequal; four upper teeth linear-lanceolate; carinal tooth very conspicuous in spike, much longer than flower bracts, ovate-lanceolate, 3-veined, almost black, 7 mm long, 2,5 mm wide; lateral teeth 6 mm long, 0,75 mm wide, longer than vexillar teeth; all densely and softly covered in white hairs, glabrous inside. **Standard** 15 mm long, 8 mm wide, claw 4 mm long, elliptic, pale lilac to deep pink, auricles prominent, appendages absent, apex truncate, closed to form a tube near the claw; glabrous. **Wing petals** 12 mm long, 3 mm wide, claw 4 mm long, billowed 4 -- 5 mm longer than the keel; sculpturing upper basal, comprised of 10 - 15 parallel transcostal lamellae. **Keel petals** 8 mm long, 4 mm wide, claw 4 mm long, 2 mm wide, blackish purple. **Androecium** 8 mm long, vexillar stamen free. **Pistil** 7 -- 8 mm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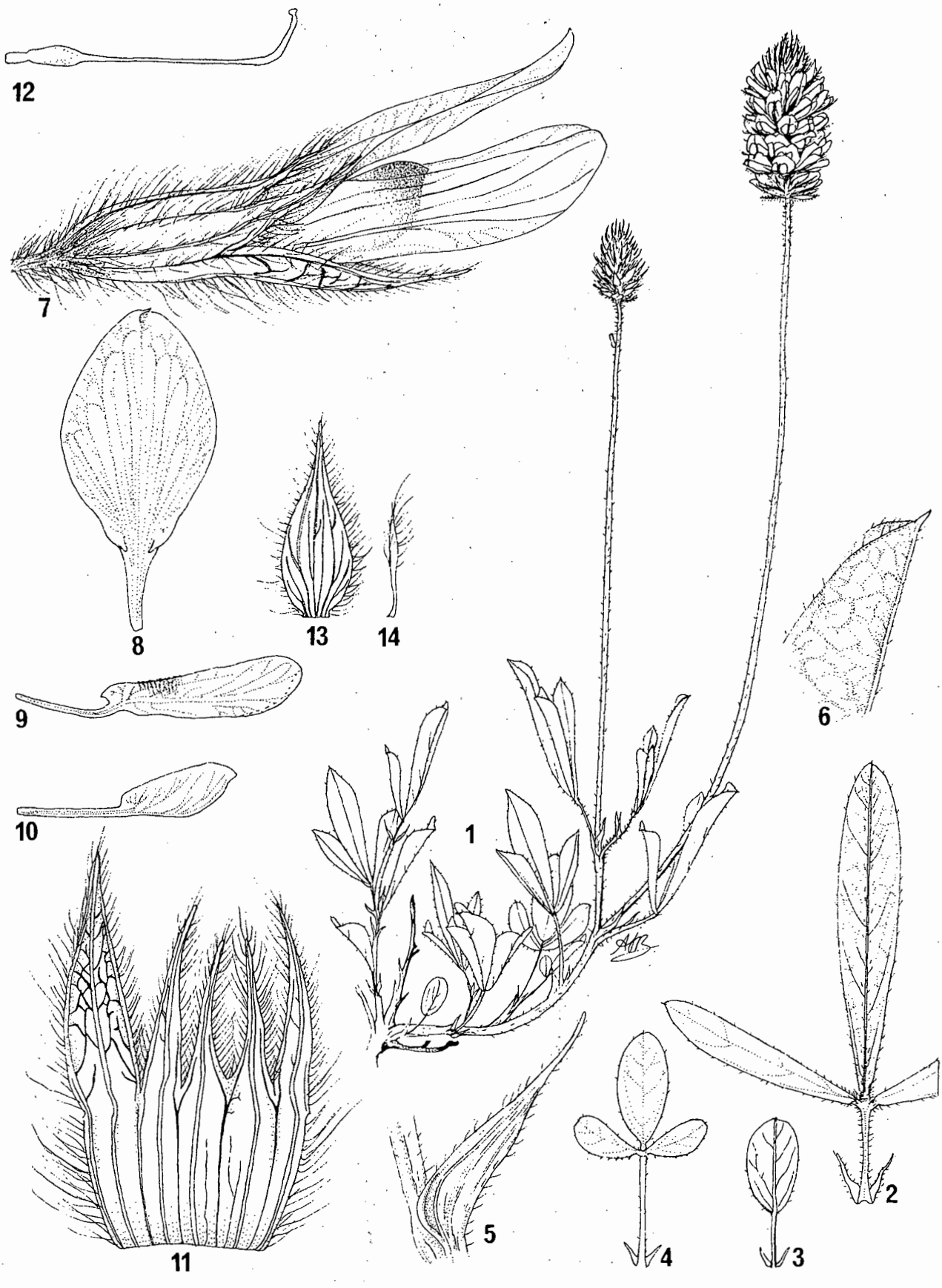

Fig. 9.97 *Otholobium zeyheri*. 1, Habit, x$^1/_2$; 2, Digitately trifoliolate leaflet, x1; 3, Leaflet at base of stem, x1; 4, First produced trifoliolate leaflet, x1; 5, Stipule, x5; 6, Apex of terminal leaflet; 7, Flower, x10; 8, Standard, 4,5; 9, Wing petal, x4; 10, Keel petal; 11, Calyx opened out, inner face, x8; 12, Pistil, x6; 13, Triplet bract, x5; 14, Flower bract, x5 (1, *Taylor 7236* and *Boucher 2023*; 2-14, *Boucher 2023*).

Fig. 9.98 *Otholobium zeyheri* Harv. Plate published by Harvey (1859). 1, habit, x1; 2, Flower, x7; 3, Calyx, x8.

long; ovary 1,5 mm long, glabrous, height of curvature 2 mm, thickened at point of flexure. **Fruits** and seeds unknown. Fig. 9.97 & 9.98.

Otholobium zeyheri inhabits the early successional stages of mountain fynbos and is found on lateritic and plinthic soils usually on rocky flats or sometimes on steep slopes (Fig. 9. 98). The massed, tall, wand-like inflorescences make a striking sight. It coppices readily after fires and is well adjusted to fire cycles. Flowering takes place from early August to late January, with peaks from November to January.

This species has been confused with *O. thomii* (Harv.) C.H. Stitron; *O. rotundifolium* (L.f.) C.H. Stirton; *O. accrescens* C.H. Stirton and *O. lanceolatum* C.H. Stirton. *O. accrescens*, *O. rotundifolium* and *O. lanceolatum* are all distinctly nigro-punctate with pustulate stems. *O. thomii* is epunctate as is *O. zeyheri* but differs in its shortly-peduncled inflorescences, densely black-haired calyces and deep purple flowers.

Specimens examined

-3318 (Cape Town): Jonkershoek Forest Station (--DD), 2-4-1975, *Hayes 1032* (STE).

-3319 (Worcester): near Appelskraal (--AA), *Zeyher 2375* (K, PRE, SAM, STE).

-3418 (Simonstown): Steenbras (--BB), 17-12-1970, *Oliver 3200* (PRE); Sir Lowrys Pass (--BB), 18-11-1896, *Schlechter 404* (GRA, K, PRE), 25-3-1915, *Burchell 8207* (K); Hottentots Holland (--BB), *Stokoe 6130* (BOL); Aries Kraal (--BD), 18-11-1944, *Compton 16489* (BOL, NBG) and *Leighton 775* (BOL, K, PRE); 30-12-1944, *Leighton 912* (BOL, PRE); 31-12-1944, *Compton 16825* (BOL, NBG); 11-1944, *Lewis 916* (NBG, SAM); Buffelskloof, Hangklip (--BD), 17-8-1953, *Barker 8040* (NBG, STE); Rooi Els (--BD). 4-11-

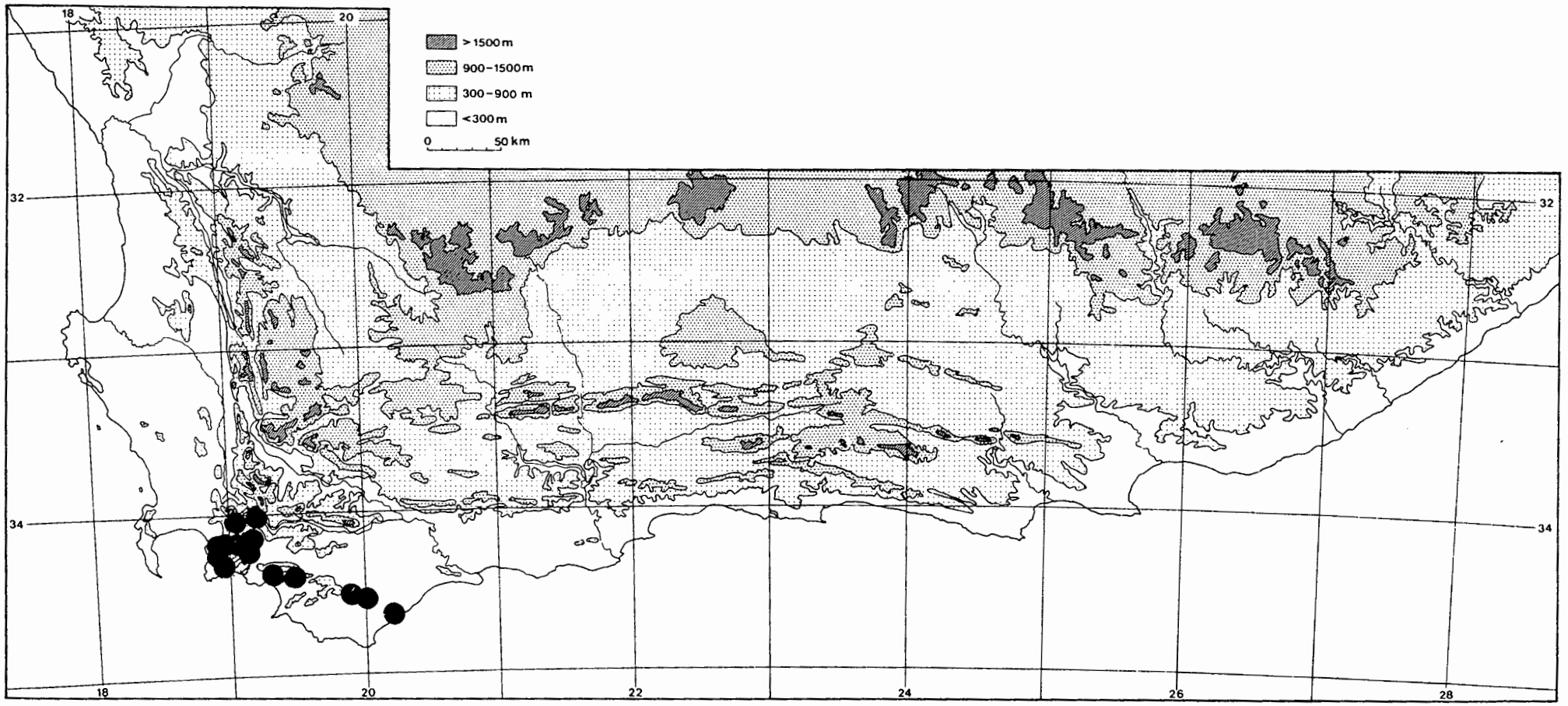

Fig. 9.99 Known distribution of *Otholobium zeyheri* (Harv.) C.H. Stirton in southern Africa.

1945, *Compton 17525* (NBG); *Leighton 1443* (BOL); 7-10-1975, *Esterhuysen 34003* (BOL); mountains near Rooi Els (--BD), 1-1923, *Stokoe* s.n. (BOL 17342); Kogelberg State Forest, lower slopes of Buffelstalberg (--BD), 23-12-1969, *Boucher 57* (PRE, STE); Platberg (--BD), 20-12-1969, *Boucher 175* (PRE, STE); Buffels River Dam Quarry (--BD), 28-9-1971, *Boucher 1619* (STE); near Highlands-Palmiet crossing (--BD), 22-11-1972, *Boucher 2023* (BOL, STE); Betty's Bay (--BD), 25-9-1955, *Brunt* s.n. (PRE, SAM); 12-1970, *Van der Schijff 7436* (PRE); Louwbos, Blousteenberge (--BD), 28-11-1981, *Stirton 1000* (K, PRE); Vogelberg, below Oudebos Forest (--BD), *Taylor 7236* (PRE, STE).

-3418 (Caledon): Houw Hoek (--AA), 1-1895, *Bolus 6935* (BOL, PRE); 14-1-1986, *Stirton 11132* (K); Bankrot Kloof, between Elgin and Villiersdorp (--AA), 11-1947, *Linley* s.n. (PRE, SAM); *Grabow* s.n. (--AA), 12-1949, *Stokoe* s.n. (PRE, SAM 61595); Palmiet River Mountains (--AA, 1-1924, *Stokoe* s.n. (BOL 17505); Fernkloof Nature Reserve (--AD), 16-6-1986, *Drewe 357* (K, NBG); flats near the foot of the mountains nesr Mosselrivier (--AD), 1-1929, *Pont 1170* (PRE); Onrust Rivier, near Klein Rivier (--AC), 29-11-1896, *Schlechter 9505* (BOL).

-3420 (Bredasdorp): Eksteen Mountains (--AA), *Zeyher* s.n. (K, PRE, SAM, TCD); Bredasdorp (--CA), 12-1929, *Turpin 2711* (BOL); 21-12-1930, *Galpin 11344* (PRE); NE of Die Dam (--CA), 18-12-1962, *Acocks 23191* (PRE).

44. Otholobium incanum C. H. Stirton, *sp. nov., O. argentei affinis sed pubescentia incana, sculptura petalium, habitu humile et inflorescentiis pseudocapitatis differt.*

Typus: 3118 (Van Rhynsdorp): 14,8 km NE of Lamberts Bay (-CB), 7-8-1968, *Acocks 19782* (PRE, holo; K, iso).

Suffrutex effusus vel virgatus usque 1 m altus; basin versus multiramosus; rami griseo-brunnei, subtiliter fissurati sparsum albo-lenticellati; ramuli juvenales florentesque pustulati incani. Folia digitatim trifoliolata petiolata. Foliola inaequalia, terminale (10) 13 -- 16 (22) mm longo, 6 -- 9 mm lato, obovato cuneato; vix mucronata, mucrone patenti, apice rotundata vel emarginata, base cuneata, lateralia quam terminale minora, symmetrica; petiolus 3 mm longus; petiolulus < 1 mm longus. Stipulae 1,5 -- 3,0 mm longae anguste triangulares, dense glandulosae, rectae, apice acutae, intus glabrae, extus sericeae. Inflorescentiae in axilibus terminalibus ramulorum brevium axillares, pseudocapitatae, 15 -- 25 mm longae, florium pedicellis brevibus 1 mm longis; flores in gregibus 6 -- 7 trifloris aggregati, grege omni a bractea persistenti breve 1 -- 2 mm longa obovata apicaliter acuta subtenta; pedunculus 5 -- 15 mm longus, folium a quo subtentus excedens. Flores 8 -- 10 mm longi, albi, ebracteati. Calicis dentes tubus 3 mm longus aequantes, aequales, triangularis, lobis 6 mm longis, 1,0 -- 1,5 mm latis, vexillaribus usque ad duas tertias longitudinis connatis; canescentes, vix vel sparse glanduloso maculati. Vexillum 8 -- 9 mm longum, 6 -- 7 mm latum late obovata. Alae 7 -- 8 mm longae, 2,0 -- 2,5 mm latae. Petala carinae 6 -- 7 mm longa, 2,5 mm lata; unguis 3 mm longus. Androecium 7 -- 8 mm longum; stamen vexillare liberum. Pistillum 7 -- 8 mm, ovarium 2,5 -- 3,0 mm longum, pubescens, glandulosum, subsessile, parte curvata 2 mm alta, stylus pro maximua parte ante partem flexuosam incrassatus; stigma penicillatum. Fructus seminaque ignoti.

Fig. 9.100 *Otholobium incanum*. 1, Flowering stem, $x^4/_5$; 2, Terminal leaflet, x5; 3, Apex of terminal leaflet, x20; 4, Side view of flower, x6; 5, Standard, x6; 6, Wing petal, x6; 7, Keel petal, x6; 8, Pistil, x6; 9, Upper part of androecial sheath split to show arrangement of stamens, x20; 10, Calyx opened out, inner face, x6; 11, Triplet bract, x12 (*Acocks 19782*).

Sprawling to virgate shrublet up to 1m tall; much branched towards the base; branches greyish brown, finely fissured and sparsely covered in white lenticels; young twigs and flowering shoots pustulate and hoary. **Leaves** digitately trifoliolate, petiolate. **Leaflets** unequal, terminal leaflet (10)13 -- 16(22) mm long, 6 -- 9 mm wide, obovate, hoary; scarcely mucronate, mucro patent, apex rounded to emarginate, base cuneate; laterals smaller than the terminal leaflet, symmetrical; petiole 3 mm long, petiolule < 1 mm long. **Stipules** 1,5 -- 3 mm long, narrowly triangular, densely glandular, straight, apex acute; glabrous inside, sericeous outside, persistent. **Inflorescences** axillary in terminal axils of short shoots, pseudocapitate, 15 -- 25 mm long, comprised of 6 -- 7 triplets of flowers borne on short 1 mm long pedicels; each set subtended by a single persistent short 1 -- 2 mm long obovate bract with acute apex; peduncle 5 -- 15 mm long, exceeding the subtending leaf. **Flowers** 8 --10 mm long, white, ebracteate. **Calyx teeth** as long as the 3 mm long tube, equal, triangular, lobes 6 mm long, 1,0 -- 1,5 mm wide, vexillar lobes fused up to two-thirds their lengths; hoary, scarcely to sparsely gland-dotted. **Standard** 8 -- 9 mm long, 6,0 -- 7,0 mm wide, claw 2 mm long; broadly elliptic, distinctly auriculate, apex emarginate. **Wing petals** 7 -- 8 mm long, 2,0 -- 2,5 mm wide, claw 3 mm long, distinctly auriculate, sculpturing upper basal and upper central, more pronounced in the upper right central region, transcostal, lamellate, up to 35 curving lamellae in a single row. **Keel petals** 6 --7 mm long, 2,5 mm wide; claw 3 mm long. **Androecium** 7 -- 8 mm long, vexillar stamen free. **Pistil** 7 -- 8 mm long; ovary 2,5 -- 3,0 mm long, pubescent, glandular, sessile; height of curvature 2 mm, style thickened maximally just before flexure, stigma penicillate. **Fruits** and seeds unknown. Fig.9.100.

Otholobium incanum is known from only three collections and was first collected in 1958 by Acocks. The species is restricted to the West Coast Sandveld (Acocks Veld Type 34) and occurs on calcareous soils usually at an altitude between 80 -- 120 m. Flowering takes place between August and October.

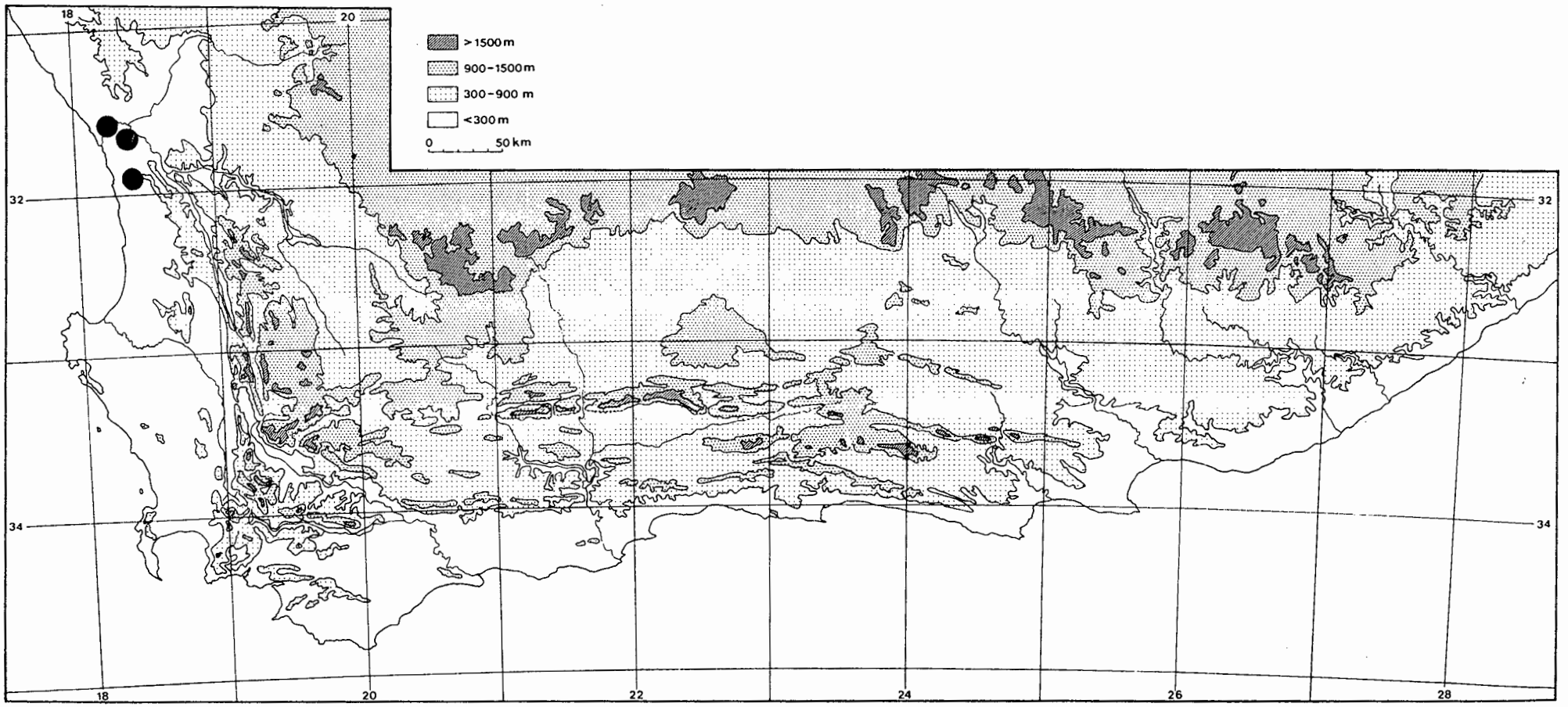

Fig. 9.101 Known distribution of *Otholobium incanum* C.H. Stirton in southern Africa.

O. incanum is characterized by its hoary vestiture, well-developed petal sculpturing and pseudocapitate inflorescences.

Specimens examined

-3118 (Van Rhynsdorp): 10,5 km WNW of Vredendal (--CB), 7-8-1968, *Acocks 24082* (PRE, STE); 17,8 km from Vredendal to Lutzville (--CB), 4-12-1981, *Stirton 10131* (K, PRE, STE, NBG); 14,8 km NE of Lamberts Bay (-CB), 7-8-1968, *Acocks 19782* (PRE, K,).

45. Otholobium thomii (Harv.) C.H. Stirton in S. Afr. J. Bot. 52: 4 (1986).

Psoralea thomii Harv. in Harv. & Sond., Fl. Cap. 155 (1862); Forbes in Bothalia 3: 129 (1930). Lectotype: Cape, without precise locality, *Thom 697* (K). Syntype: "C.B.S.", *Bowie* s.n. (K).

Small suffrutex up to 40 cm in height, coppicing after fire. **Stems** 8 --10 cm long, scarcely branched, decumbent, squared in transverse section, distinctly ridged. **Leaves** unifolioate, basal leaves of stem smallest. **Leaflets** 25 -- 40 mm long, 12 -- 23 mm wide, elliptic, basal leaflets circular to transversely broadly elliptic, mucronulate, base obtuse, impunctate, margin scaberulous, younger leaves hairy, older leaves hispid or glabrescent; rachis absent; petiole 3 -- 4 mm long, petiolules 1,0 -- 1,5 mm long. **Stipules** 6 -- 8 mm long, 2,0 mm wide, lanceolate-subulate acute, 5-nerved, pilose. **Inflorescence** axillary, broadly ovate, congested, 30 -- 60 mm long, comprised of 3 -- 7 triplets of pedicelled flowers, each triplet subtended by a 7 -- 9 mm long, 2,5 -- 3,0 mm wide, obovate, acuminate bract; peduncle 25 -- 60 mm long, 2x > length of leaflets. **Flowers** light to deep purple, 11 -- 12 (16) mm long; bracts caducous. **Calyx teeth** longer than the 2 -- 4 mm long tube, teeth unequal; four upper teeth subulate; carinal tooth naviculate, prominently veined; carinal lobe 11 -- 17 mm long, 2,5 -- 4,0 mm wide, lateral lobes 10 -- 14 (15) mm long, longer than vexillar lobes; all densely covered with a mixture of long black and long white hairs, glabrous to densely hairy on inner face of teeth; vexillar lobes not fused above the tube. **Standard** 13 -- 20 mm long, 8,0 -- 8,5 (15,0) mm wide, claw 1,5 -- 2,0 (4,0) mm long; ovate, oblong, deep purple with white nectar patch separated by a purple V, appendages absent, auricles scarcely developed. **Wing petals** 12 -- 16 mm long, 4,0 -- 4,5 mm wide, narrowly oblong, upcurving, auriculate, claw 3 -- 6 mm long; longer than keel blades; sculpturing upper basal and central comprised of up to 30 irregular transcostal and intercostal lamellae. **Keel blades** 9 -- 11 mm long, 3 -- 5 mm wide, claw 4 mm long. **Androecium** 10 mm long, vexillar stamen free; anthers equal,

Fig. 9.93 *Otholobium sericeum*. 1, Flowering shoot, x1; 2, Trifoliolate leaflet, x1; 3, Stipules, x3; 4, Standard, x3; 5, Standard, side view, x3; 6, Androecium, x5; 7, Pistil, x5; 8, Wing petals, x4; 9, Keel petals, x4; 10, Calyx opened out, inner face, x2; 11, Triplet bract, x3; 12, Flower bract, x3 (*Britten 2980*).

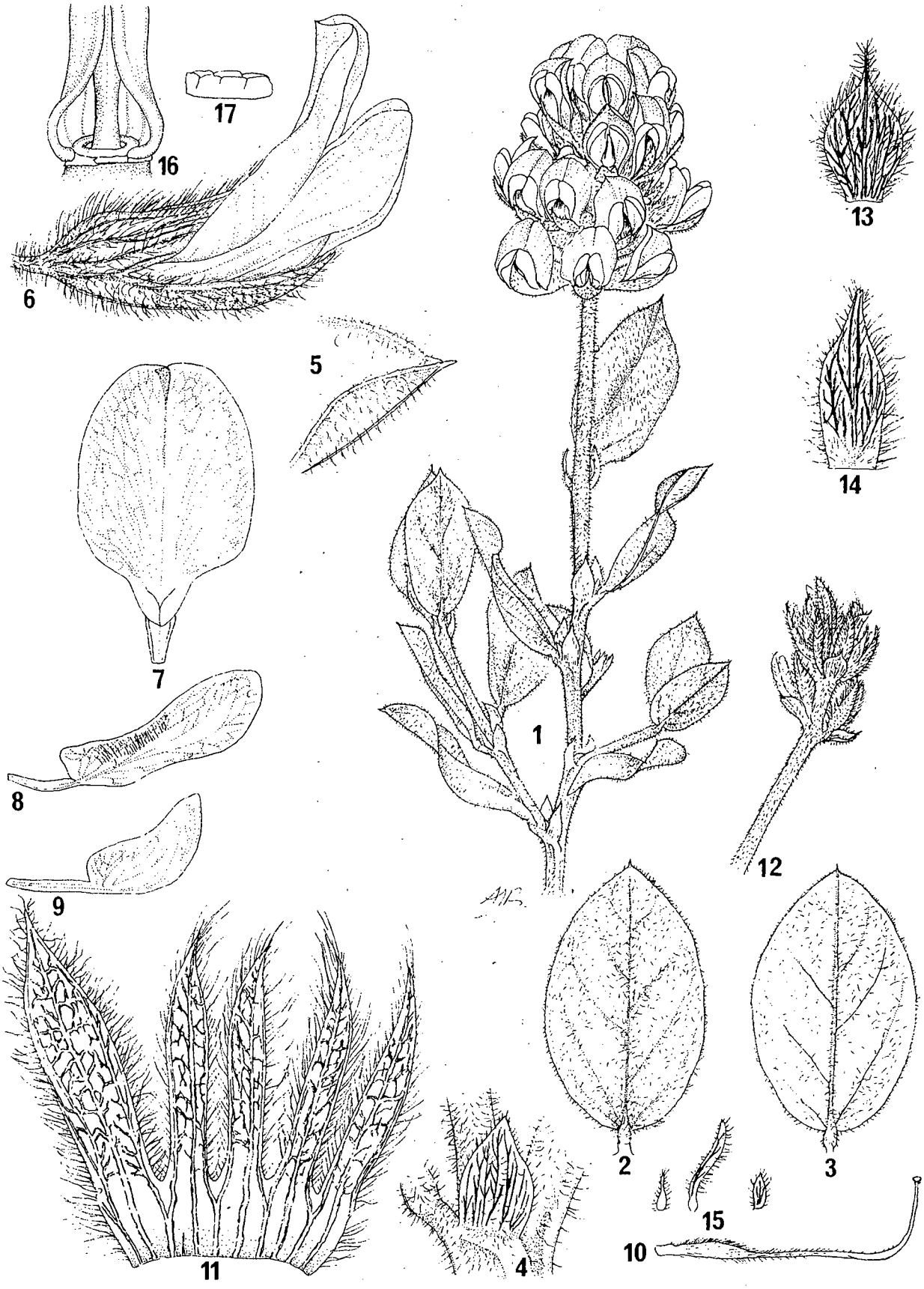

Fig. 9.102 *Otholobium thomii*. 1, Upper parts of flowering stem, x1; 2, Unifoliolate leaf, upper surface, x1,5; 3, Unifoliolate leaf, lower surface, x1,5; 4, Stipule, x3; 5, Apex of leaflet, x3; 6, Flower, x2; 7, Standard, x3; 8, Wing petal, x3; 9, Keel petal, x3; 10, Pistil, x4; 11, Calyx opened out, x5; 12, Fruiting calyces, x1; 13, Triplet bract from near top of inflorescence, x3; 14, Triplet bract from near base of inflorescence, x3; 15, Flower bracts, x3; 16, Fenestrae at base of androecial sheath, x10; 17, Nectary, x15 (*Stirton 11380*).

0,7 -- 0,8 mm long. **Pistil** 7 -- 10 mm long; ovary 1,5 -- 4,0 mm long, pilose, height of curvature 3 -- 4 mm long, thickened just before the point of flexure, hairy for one third its length; stigma capitate, penicillate. **Seeds** and fruits unknown. Fig 9.102.

Otholobium thomii resprouts in bare areas or in recently burnt veld and grows at an altitude of 300 -- 600 m in mountain fynbos. Flowering takes place from late July through to December. Fig. 9.103.

There is an east-west cline of decreasing flower size, peduncle length and degree of blackness of the pubescence. The robust large-flowered specimen *Turpin* s.n. (BOL 32237) from the Bredasdorp area could represent a distinct species, but more material is meeded. This specimen has much larger flowers and an inflorescence 2 -- 3 times longer than the leaves.

This very variable species is related to *O. zeyheri* and can be separated from that species by its thick, shortly peduncled inflorescences, deep purple flowers and purple-flushed calyces.

Specimens examined

-3419 (Caledon): Caledon (--AB), 14-9-1935, *Compton* s.n. (BOL); Fernkloof Reserve, Hermanus (--AC), 6-11-1966, *Barker 10487* (NBG); 31-10-1986, *Stirton & Zantovska 11380* (BOL, K, MO, P, PRE); Rotary Drive, Hermanus (--AC), 5-7-1970, *Barker 10688* (NBG); *Robertson 434* (FNR); Onrust (--AC), 10-1929, *Levyns 3081* (BOL); 1-6-1964, *Horrocks 173* (NBG); 12-8-1938, *Goldblatt 3012* (MO, NBG); Klein Riviers Mountains (--AC), 1-12-1896, *Schlechter 9503* (BOL); Highlands (--AC), 12-8-1938, *Compton 7392* (NBG); Onrus (--AC), 30-9-1924, *Compton* s.n. (BOL 3454); 5 km from Hawston to Kleinmond (--CC), 14-1-1986, *Stirton 11129* (K).

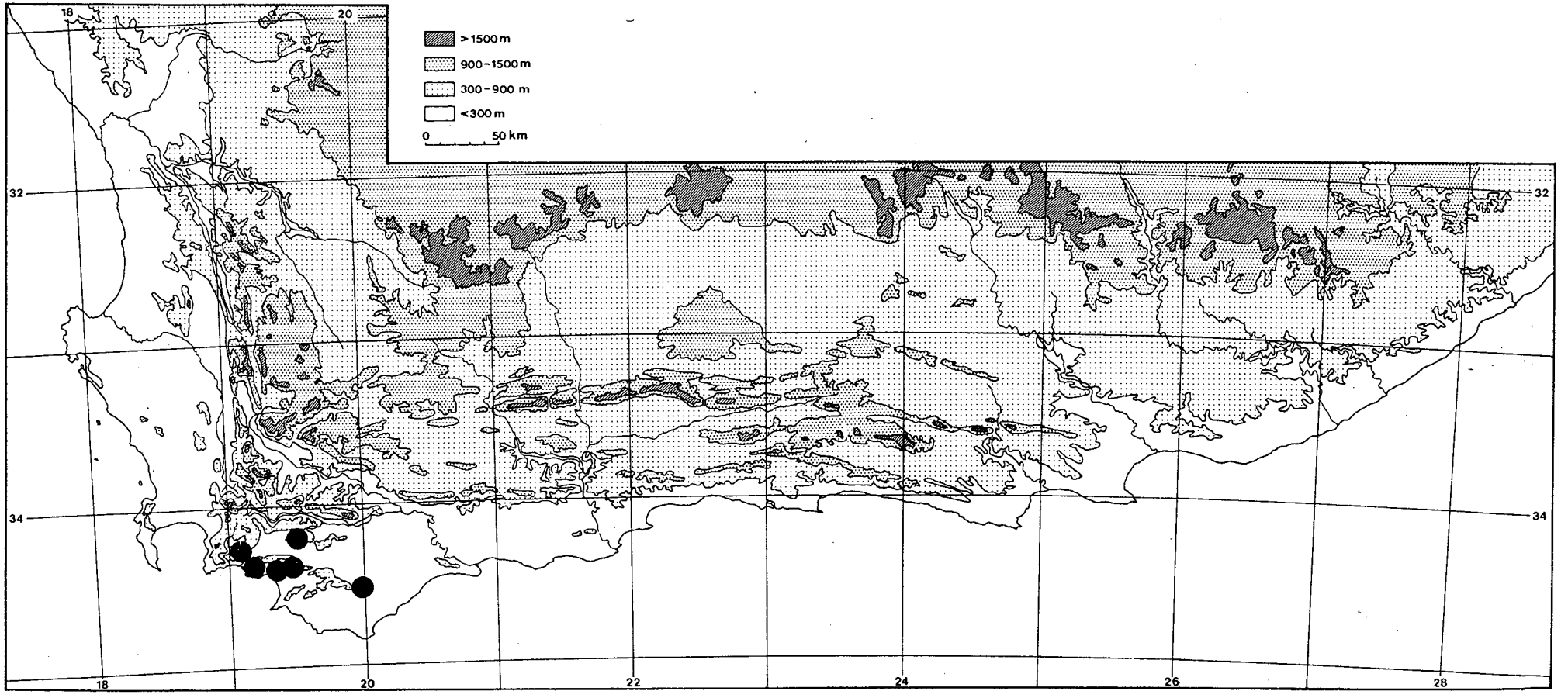

Fig. 9.103 Known distribution of *Otholobium thomii* (Harv.) C.H. Stirton in southern Africa.

-3420 (Bredasdorp): Bredasdorp (--CA), 11-1929, *Turpin* s.n. (BOL 32237).

Without precise locality: "C.B.S.", 1822, *Thom 697* (K).

46. Otholobium dreweae C.H. Stirton, *sp. nov., O. thomii (Harv.) C.H. Stirton affinis sed habitu denso, foliis scabridis, compactis rotundatis floribus violaceis differt.*

Typus: 3419 (Caledon): Fernkloof Nature Reserve (--AD). 5-11-1986, *Drewe 450* (HER, K).

Suffrutex parvus sparse foliatus usque 150 mm altus; post incendia novibus ramis e base orientibus. Caules multi erecti, foliis basalibus minimis. Folia unifoliolata, erecta, petiolata, 30 -- 40 mm longa, 10 -- 16 mm lata, elliptica, apice cuspidata, base acuta, scabriduscula, impunctata; petiolus 4 -- 5 mm longus, petiolulus 1 mm longus. Stipulae 6 -- 9 mm longae, 2,0 -- 2,5 mm latae, subulatae, glabrae, 5 -- 6 nervatae. Inflorescentiae axillares, 1 (2) in axilibus superioribus, in ramulis brevibus annuis terminales, compactae, 25 -- 30 mm longae; flores pedicellati in gregibus 4 -- 6 trifloris aggregatae grege omni a a bractea lanceolata, acuminata, 10 -- 13 mm longa, 7 -- 9 mm lata subtenta; pedunculis 25 -- mm longus non folium a qua subtentus excedens. Flores violaceis, 15 -- 17 mm longi. Dentes calycis quam tubus 8 -- 9 mm longus longiores, inaequales, lanceolatae; dens carinalis lattisimus, naviculatis, lobi vexillares falcati laterales aequantes albis brevis patentibus longis atris obtecti intus glabri. Vexillum 16 -- 17 mm longum, 13 - 14 mm latum, late ovatum, glabrum. Alae 16 -- 17 mm longae, 3 -- 4 mm latae, carina excedentes. Petala carinae 12 mm longae, 4 mm latae. Androecium 11 mm longum, stamine decimo libero, fenestratum. Pistillum 12 -- 13 mm longum; ovarium 3 mm longum, parte curvata 4 mm alta, entase ad partem curvatam incrassato; stigma penicillatum. Fructus 5,0 -- 5,5 mm longi, 3,0 -- 3,5 mm lati, distincti reticulati. Semina 4 mm longa, 2,5 mm lata.

Small suffrutex up to 15 cm in height, coppicing after fire, forming large clumps, often mat-like; ligno-tuber present. **Stems** up to 15 cm long, scarcely branched, erect, distinctly ridged on the corners. **Leaves** unifoliolate, basal leaves of stem smallest. **Leaflets** 30 -- 40 mm long, 10 -- 16 mm wide, elliptic, basal leaflets circular, cuspidate,

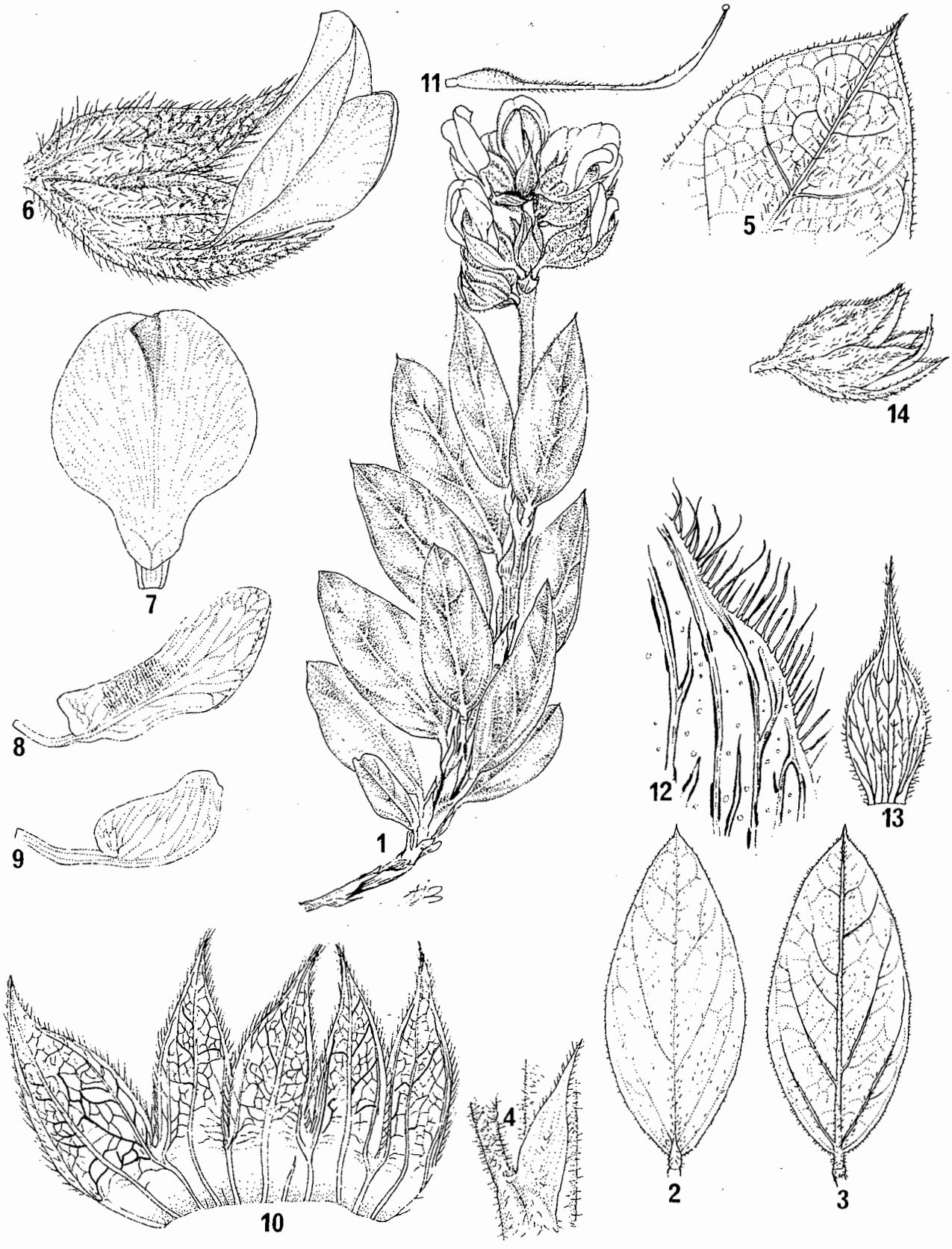

Fig. 9.104 *Otholobium dreweae*. 1, Flowering shoot, x1; 2, Upper surface of leaflet, x1,5; 3, Lower surface of leaflet, x1,5; 4, Side view of stipule, 3; 5, Apex of leaflet, x4; 6, Side view of flower at anthesis, x4; 7, Standard, inner face, x3; 8, Wing petal, x3; 9, Keel petal, x3; 10, Calyx opened out, inner face, x4; 11, Pistil, x4; 12, Margin of triplet bract, x20; 13, Triplet bract, x3; 14, Fruiting calyx, x2 (*Drewe 450*).

base acute; impunctate, margin scaberulous, scabridusculus, hairs mostly on the veins; petiole 4 -- 5 mm long, petiolules 1,0 mm long. **Stipules** 6 -- 9 mm long, 2,0 --2,5 mm wide, subulate, attenuate, 5 -- 6 nerved, glabrous except for scabrellous margins. **Inflorescences** solitary in uppermost axil, rounded, compact, 25 -- 30 mm long, comprised of 4 -- 6 triplets of pedicellate flowers, each triplet subtended by a 10 -- 13 mm long, 7 -- 9 mm wide, lanceolate, acuminate bract; peduncle 25 -- 30 mm long, about length of leaflets. **Flowers** deep reddish (clerical) purple, 15 -- 17 mm long; bracts persistent. **Calyx teeth** 2,0 -- 2,5 times longer than the 4 mm long tube, teeth equal; four upper teeth lanceolate, carinal tooth naviculate; venation thick, reticulate; carinal lobe 15 -- 16 mm long, 5,5 -- 6,0 mm wide, lateral lobes 3 -- 4 mm wide, equal to vexillar lobes; all covered in erect very short white hairs and long black hairs, glabrous on inner face. **Standard** 16 -- 17 mm long, 13 -- 14 mm wide, claw 2 mm long, recurved; broadly ovate, reddish purple, appendages absent, auricles prominent, glabrous. **Wing petals** 16 -- 17 mm long, 7 mm wide, spathulate, upcurving, auriculate, claw 5 mm long, longer than keel blades; sculpturing upper basal and central comprised of 50 -- 60 broad transcostal lamellae. **Keel blades** 12 mm long, 4 mm wide, apex rounded with beak below, claw 5 mm. **Androecium** 11 mm long; vexillar stamen free, anthers equal, 0,7-0,8 mm long, fenestrate. **Pistil** 12 -- 13 mm long; ovary 3 mm long, pilose; height of curvature of style 4 mm long, thickened at curvature, hairy until curvature, stigma capitate, penicillate. Fruits 5,0 -- 5,5 mm long, 3,0 -- 3,5 mm wide, distinctly ribbed, texture papery, finely white pubescent. **Seeds** 4 mm long, 2,5 mm wide, pale brown with small purple blotches towards the hilar area, becoming longitudinally broader. Fig. 9.104.

Otholobium dreweae was collected for the first time as recently as November, 1986 by Mrs. P.B. Drewe, Curator of the Hermanus Herbarium. The species has been found on the Kleinrivier Mountains in dense clumps on recently burned veld, in two separate colonies 1 km apart (Fig. 9.105). It occurs on shale bands in mountain Fynbos at about 400 m altitude. Flowering occurs in November.

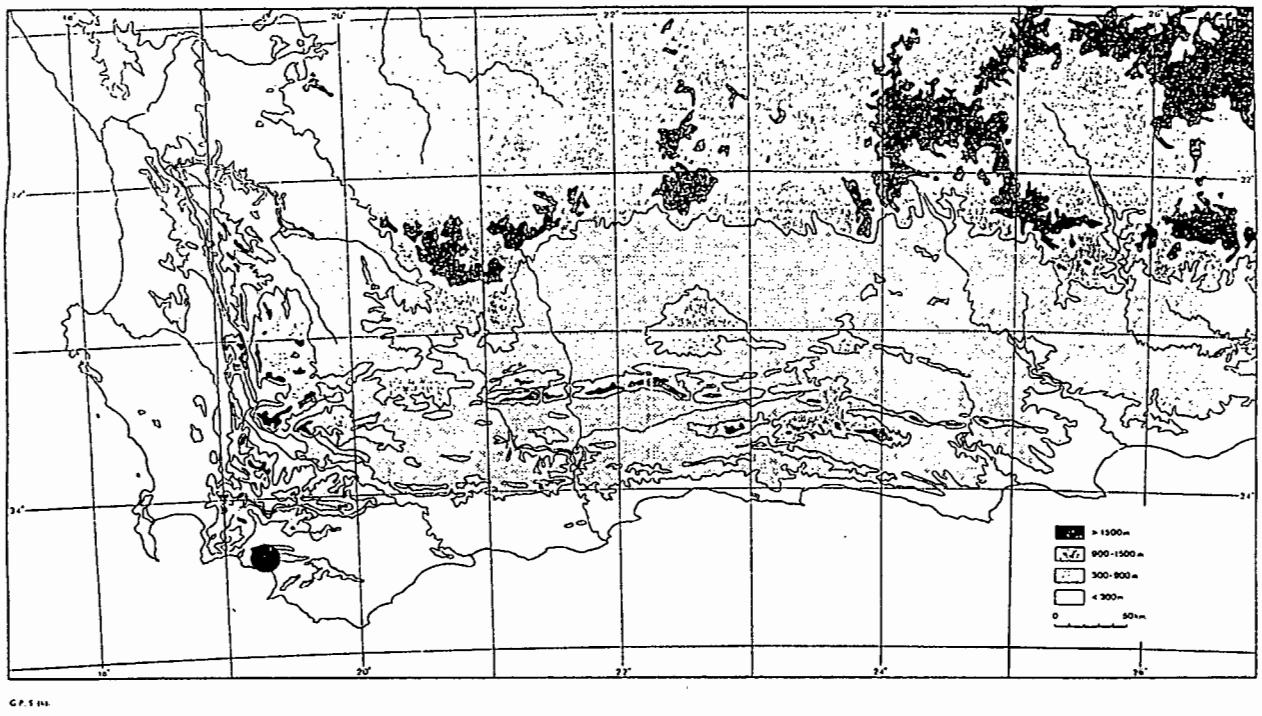

Fig. 9.105 Known distribution of *Otholobium dreweae* C.H. Stirton in southern Africa.

O. dreweae is related to *O.thomii* but difffers from that species in its differently haired calyx, more reddish purple flowers, rounder and more compact inflorescences, stiffer scabrid leaves, differently shaped keel petals and calyx lobes.

Specimens examined

-3419 (Caledon): Fernkloof Nature Reserve (--AD), 5-11-1986, *Drewe 450* (HER, K).

47. Otholobium caffrum (Eckl. & Zeyh.) C.H. Stirton in Adv. Leg. Syst. 341 (1981); S. Afr. J. Bot. 52: 4 (1986).

Psoralea caffra Eckl. & Zeyh., Enum. 230 (1836); Walp., Repert. 1: 657 (1842); Harv. in Harv. & Sond., Fl. Cap. 2: 155 (1862); Forbes in Bothalia 3: 133 (1930). Lectotype: "In collibus graminosis inter flumine Katrivier et Keyrivier", *Ecklon & Zeyher* s.n. (S, lecto; G, K, L, MEL 1541957, MO, SAM, W, iso).

P. royffei Forbes in Bothalia 3: 136 (1930). Holotype: Cala, Tembuland, *Royffe 61* (GRA).

P. caffra Eckl. & Zeyh. sensu Trauseld, Wildflow. Natal Drakensberg 103, photo on p. 102 (1969) is *Otholobium fumeum* C. H. Stirton.

Erect, either single-stemmed slender and straggly or a semi-scandent coppicing shrub up to 2,5 m tall. **Stems** branched from the middle upwards, greyish brown, somewhat striate, densely pustulate; twigs tomentulose. **Leaves** pinnately-trifoliolate, petiolate. **Leaflets** variable in size, those in the lower parts of the branches being much larger than those subtending the flowering axils; terminal leaflet twice the size of the two lateral leaflets, 30 -- 46 mm long, 24 -- 35 mm wide, very broadly elliptic to broadly obovate (laterals broadly elliptic), spreading, held at 45 - 60 , crinkled along margins, mucro arching, sharp; apex distinctly emarginate, pellucid-dotted when fresh, drying black; younger leaves finely pubescent, encrusted with distinct raised hemispherical glands, mature leaves glabrous, midrib prominently glandular, upper surface nitid; dark green; petiole 8 -- 22 mm long, channelled, pustulate; petiolules glandular. **Stipules** 3 -- 4 mm long, narrowly triangular, about one third to one fifth length of the petiole, clasping the stem, becoming senescent, persistent. **Inflorescences** axillary, up to 30 per shoot,

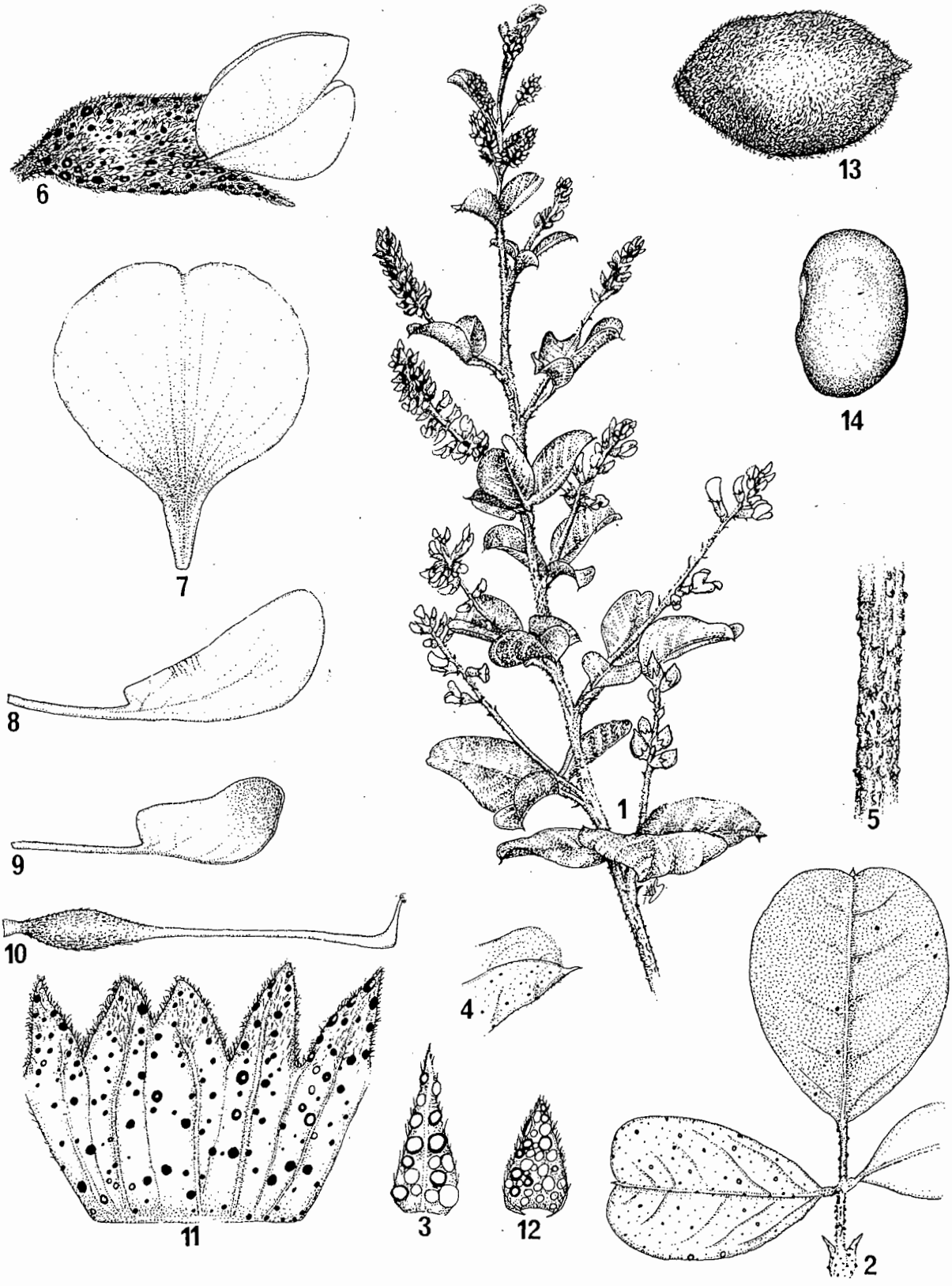

Fig. 9.106 *Otholobium caffrum*. 1, Flowering branch, x$^1/_2$; 2, Pinnately trifoliolate leaflet, x1,5; 3, Stipule, x7; 4, Apex of terminal leaflet, x1,5; 5, Stem, x3; 6, Side view of flower at anthesis, x6; 7, Standard, inner face, x6; 8, Wing petal, x7; 9, Keel petal, x7; 10, Pistil, x10; 11, Calyx opened out, inner face, x9; 12, Triplet bract, x6; 13, Fruit, x6,5; 14, Seed, x7 (12 & 3, *Strey 8688*; rest *Flanagan 2294*).

elongating, somewhat lax, up to 70 mm long, about twice the length of the subtending leaves, peduncle 40 -- 60 mm long, comprised of 14 -- 20 triplets of 1 -- 2 mm pedicellate flowers, each triplet subtended by a 1 mm long, broadly cuspidate, senescent, persistent bract, glandular. **Flowers** 10 -- 11 mm long, pale mauve, ebracteate. **Calyx teeth** much shorter than 3,5 -- 4,0 mm long tube; unequal, acute, carinal lobe broader and longer than other lobes; lobes (5)6 -- 7 mm long, 1,0 -- 1,5 mm wide; vexillar lobes fused higher up than the rest; sparsely to densely covered in fine black woolly hairs on the outside and on the inner face of the teeth, densely to sparingly glandular, glands over entire surface. **Standard** (7,5)9 -- 10 mm long, 6,0 -- 6,5(8,0) mm wide, broadly elliptic, pale mauve with violet patch in the centre overarching a purple flecked area above the white nectar patch; scarcely reflexed, sides flared backwards, auricules weakly developed, claw 2mm long, channelled, apex emarginate. **Wing petals** (8)9 -- 11 mm long, (2,0)2,5 -- 3,0 mm long, claw 3 -- 4 mm long, longer than keel petals; sculpturing upper central, comprising 20 -- 30 irregular transcostal lamellae, rows indistinct. **Keel petals** 7,0 -- 7,5 mm long, blade 3,5 mm long, 1,8 -- 2,0 mm wide, claws 3 -- 4 mm long. **Androecium** 6 mm long, split adaxially, fenestrate, tenth stamen fused to sheath in lower third. **Pistil** 7 mm long; ovary 1,5 -- 2,0 mm long, densely pubescent, height of curvature 1,5 mm, sloping forwards or erect; style sparsely hairy along upper margin up to the entasis which is developed before the curvature. **Fruits** 5 -- 6 mm long, 3 -- 4 mm wide, distinctly beaked, reticulate, rounded, finely pubescent; much exceeding the calyx. **Seeds** 4 -- 5 mm long, 2 -- 3 mm wide, chestnut brown. Figs. 9.106 - 108.

Otholobium caffrum appears to be a localized component of Acocks Veld Type 44, Highland Sourveld and Dohne Sourveld and extends from the Katberg Mountains in the South to the Natal Midlands in the north (Fig. 9.109). It is found predominantly along forest margins and along rocky outcrops in grassland near forest but may also occur in open patches in forest or on mountain grassland, usually at an altitude between

Fig. 9.107 *Otholobium caffrum*. 1, Habit and typical habitat, Mhlahani Forest Reserve, Transkei. Notice remnant stems from previous fire cycle; 2, Apex of a flowering shoots (*Stirton 11141*).

1000 -- 2200 m. Flowering is protracted and sporadic, as for most of the eastern species, and takes place between late October to early August with distinct peaks from February to April.

O. caffrum is most easily confused with *O. fumeum* C.H. Stirton but differs from that species in its fewer-flowered laxer inflorescences, more densely glandular and less hairy calyces, glabrous leaflets and scarcely pedicellate flowers.

Psoralea royffei H.M.L. Forbes based on *Royffe 61* from Cala in Tembuland needs further investigation in the field. I have not seen live specimens of this taxon but include it here because of its similarity to *O. caffrum*, some notable differences notwithstanding. It differs from *O. caffrum* in its densely black woolly calyces, scarcely pustulate stems, shorter, fewer and smaller-flowered, more compact inflorescences, and finally, densely black woolly fruits. *Acocks 13792* from transitional short forest 9 km SSW of Ixopo is a good match of the type. *Hilliard & Burtt 8046* from the Zuurberg is an intermediate form between the two extremes. There is a cline of increasing pubescence and decreasing glandulosity as one moves from south to north and until more material is collected in the Transkei the apparent differences between northern and southern populations may just be nothing more than an artefact of collecting. Another aberrant non-pustulate collection requiring re-examination is from the population growing on the summit of Bastervoetslaan on the road between Ugie & Elliot (*Roux 1198*).

Specimens examined

-2830 (Dundee): Weenen (--CC), 2-1924, *Rogers 27804* (PRE).

Fig. 9.108 *Otholobium caffrum*. 1, Terminal flowering seasonal shoot; 2-3, Portion of the upper part of a new shoot, notice raised pustules, diagnostic of this eastern species (*Stirton 11141*).

-2929 (Underburg): Upper Loteni Valley, Ash Cave vicinity (--AD), 6-2-1985, *Hilliard & Burtt 18145* (E, K, NU); Loteni Forest Reserve, 13-3-1973, *Wright 1461* (E); Polela (--CB), 2-1896, *Maurice & Evans 659* (K, NH); *Fernando* s.n. (NH 10468); Boston (--DB), 21-4-1905, left hand specimen, *Wood 9930* (PRE), 12-3-1909, *Wood 11155* (E); Marwaga Mountain, Bulwer (--DC), 12-3-1926, *McClean 209* (G, PRE); Kumba Mountain, 7,7 miles north of Bulwer on road to Impendhle (--DD), 1-2-1957, *Marais 1464* (K, PRE); 5 km from Donnybrook on Ixopo road (--DD), 27-3-1963, *Edwards 3100* (PRE).

-2930 (Pietermaritzburg): Lidgetton (--AC), 11-3-1897, *Wood 6320* (PRE); The Dargle (--AC), 13-2-1922, *Wilson 131* (GBH, PRE); Greytown (--BA), 4-1930, *Wylie* s.n. (K, NH 27725, NH 20501, PRE); Umgeni (--CA), 1862, *Cooper 1148* (BOL, K, TCD, W); Byrne/Keerom (--CC), 21-4-1973, *Strey 11270* (K, NH, PRE); Richmond (--CD), *Wood 338* (E, MEL 1541960); 5-1883, *Wood 1847* (K, PRE).

-3029 (Kokstad): Clydesdale, Umzimkulu (--BD), 12-1884, *Tyson 1260* (E, BOL, G, K, SAM, W); Ingeli Mountain, Weza (--DA), 16-12-1981, *Stirton 1036* (K, PRE); 26-2-1975, *Hilliard & Burtt 8046* (E, K); 17-3-1972, *Nicholson 1223* (PRE); 17-2-1977, *Nicholson 1706* (PRE); Ntlenzi (--DC), 22-5--1969, *Strey 8688* (K, NH, PRE).

-3030 (Port Shepstone): 5 miles S.S.W. of Ixopo (--AA), 20-6-1947, *Acocks 13792* (K, PRE).

-3127 (Lady Frere): Big Bush, Cala (--DA), 2-10-1910, *Royffe 161* (GRA); Little Bush (--DA), 2-1910, *Kolbe & Pegler 1740* (BOL, 2-PRE).

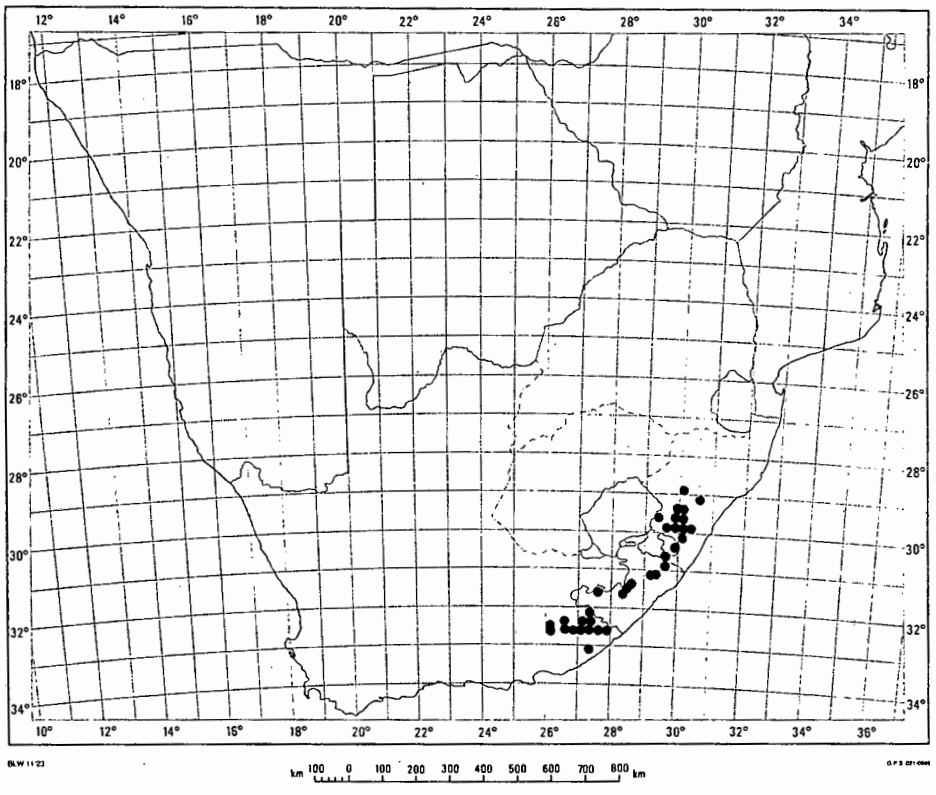

Fig. 9.110 Known distribution of *Otholobium caffrum* (Eckl. & Zeyh.) C.H. Stirton in southern Africa.

-3128 (Umtata): Bastervoetslaan, between Ugie and Elliot (--AA), 20-1-9182, *Roux 1198* (PRE); Mhlahani Forest Reserve (--BC), 24-1-1986, *Stirton 11141* (K, NBG); 31-1-1983, *Hutchings 201* (TRANS); Basiza Mountain, Mbolompo Valley (--CB), 11-2-1981, *Burtt 13938* (PRE); 1-2-1983, *Hutchings 219* (TRANS); 11-2-1981, *Hilliard & Burtt 13938* (E, K, PRE).

-3129 (Port St Johns): Bulembu Forest margin (--AB), *Kotze 597* (PRE).

-3226 (Fort Beaufort): Baviaansrivierberg on Shone's farm, Bedford (--AC), 19-4-1950, *Killick 841* (PRE); Katberg (--BC), *Baur 1068* (K); 5-1869, *Bolus 1993* (BOL); 5-1869, *Bolus 1780* (BOL); *Ecklon & Zeyher* s.n. (MEL 1541961); 3-1896, *Galpin 2068* (BOL, PRE); 23-2-1980, *Germishuizen 1579* (PRE); *Hutton* s.n. (K, TCD); Katberg Pass (--BC), 11-7-1931, *Levyns 3700* (BOL); 11-7-1931, *Martin 172* (NBG); Banderskop (--BC), 15-3-1940, *Moore 7* (NBG); Katrivier & Keyrivier (-- BC), *Ecklon & Zeyher 1550* (G, K, L, MEL 1541957, OXF, S, W); Kagaberg Mountain (--CA), *Macowan 518* (BOL, TCD); *Macowan 1118* (K); Tor Doone (--DB), 13-2-1943, *Giffen 1310* (PRE), 8-2-1935, *Holland 4115* (BOL); 2-1927, *Giffen 233* (PRE); 4-5-1954, *Schirach 260* (NBG); Hogsback Forest Reserve (--DB), 25-11-1969, *Dahlstrand 1836* (PRE, STE); Little Timbers (--DB), 22-6-1966, *Wells 3637* (K, PRE).

-3227 (Stutterheim): eastern slopes of Windvogelberg (--AC), 22-4-1906, *Galpin 7361* (K, PRE); 4-1962, *Roberts 1772, 1774* (PRE); Fort Cunnynghame (--AD), *Sim 2300* (NBG); Hogsback (--CA), 2-10-1961, *Batten 79* (NBG); 16-12-1940, *Barker 895* (NBG); 5-1932, *Leighton* s.n. (BOL 32235); 30-4-1955, *Lewis 4695* (PRE, SAM); *Rattray 32a* (PRE); Kettlespout Falls (--CA), 13-4-1955, *Johnson 1167* (PRE); Gubu River valley (--CB), 21-11-1942, *Dick 12* (PRE); banks of Kubushie River (--DA), 24-4-1943, *Acocks*

9782 (PRE); Toise River mountains (--DA), 3-1894, *Flanagan 2294* (PRE, SAM); Amabele (--DA), 21-1-1940, *De Vries 69* (PRE); Komgha (--DB), 3-1894, *Flanagan 2319* (PRE).

-3327 (Peddie): Keiskamma Hoek (--AB), 4-1944, *Goulimis* s.n. (PRE 55369).

Without precise locality: Cap de Bonne Esperance, *Drege* s.n. (PRE 26946); *Junod 42* (G); Inahwagua Falls, 2-1894, *Maurice & Evans 225* (NH); Benvie, 7-5-1900, *Wood 7788* (MEL 1541959), *Wood* s.n. (E).

48. Otholobium gazense (Bak.f.) C. H. Stirton, comb. nov.

Psoralea foliosa Oliv. var. *gazense* Bak.f. in J. Linn. Soc. 40: 52 (1911). Holotype: Leikipia Plateau, Melsetter District, Zimbabwe, 20-9-1906, *Swynnerton 1417* (K, holo; BM, iso).

Small densely leafy or tall virgate shrub up to 3 m tall. **Branches** silvery or tawny tomentose. **Leaves** digitately trifoliolate, dense, or lax and spreading, petiolate, stipulate. **Leaflets** subequal, symmetrical; terminal longest, 20 -- 35 mm long, 8 -- 14 mm wide, obovate to oblong-obovate, rarely oblanceolate, recurved-mucronate, apex rounded to emarginate, base cuneate, sparingly pubescent, glabrescent, glands of upper surface much smaller and more numerous than on lower surface, crateriform; petiole 1 -- 2 mm long, petiolule < 1 mm long. **Inflorescences** few to many in congested heads in upper axils of seasonal shoots, visible among leaflets; comprised of 3 -- 15 triplets of 2 mm long pedicellate flowers, each triplet subtended by a 1,5 -- 2,0 mm long, cucullate, ovate or oblong, glandular, ciliate persistent bract. **Flowers** 8 -- 9 mm long, pedicel 2,0 -- 2,5 mm long; bract short, linear. **Calyx teeth** shorter than corolla, teeth subequal; carinal lobe longest, lanceolate, 6 mm long, other four lobes equal, triangular, vexillar teeth not fused above 3 mm long tube; ribs prominent, teeth ciliate, sparsely pubescent and glandular, pellucid. **Standard** 9 mm long, 7 mm wide, claw 3 mm long, oblong-ovate, emarginate, auriculate. **Wing petals** 9 mm long, 2 mm wide, claw 3 mm long, auriculate, much larger than keel; sculpturing present, upper central, comprising up to 15 transcostal lamellae, rows indistinct. **Keel petals** slightly fused to wing petals near auricles, 6,5 -- 7,0 mm long, 2 mm wide, claw 3,5 mm long. **Androecium** 6 mm long, pseudomonadelphous, fenestrate. **Pistil** 6 mm long; ovary 1,5 mm long, stipitate 1 mm long, sericeous, extending one third along the style, entasis well-developed before the point of flexure, height of

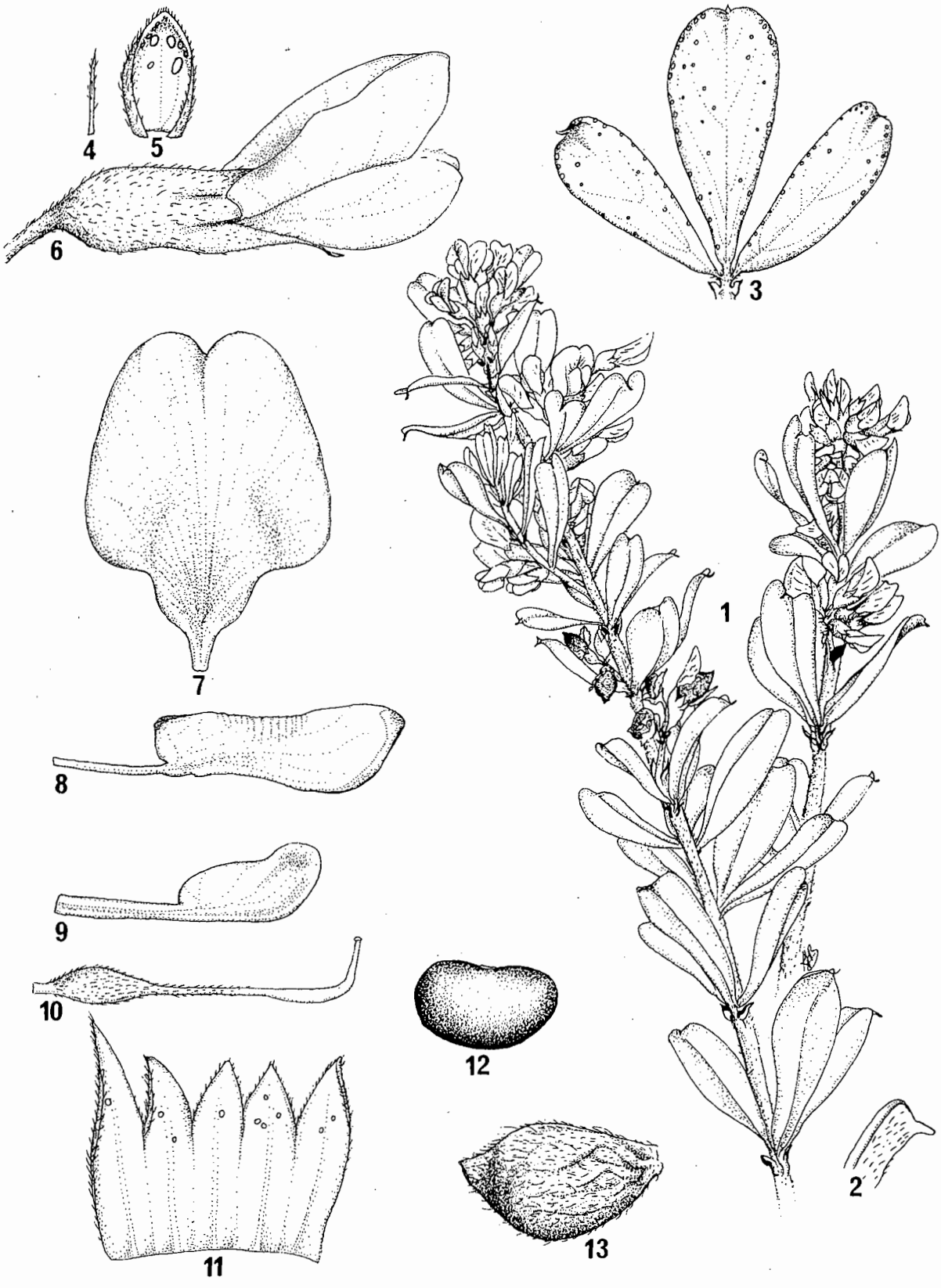

Fig. 9.111 *Otholobium gazense*. 1, Flowering branch, x1; 2, Apex of terminal leaflet, x2; Digitately trifoliolate leaflet, terminal showing upper surface, laterals lower surfaces, x2; 4, Flower bract, x10; 5, Triplet bract, x10; 6, Side view of flower, x7; 7, Standard, x5; 8, Wing petal, x6; 9, Keel petals, x6; 10 Pistil, x10; 11, Calyx opened out, inner face, x7; 12, Seed, x6; 13, Fruit, x5 (*Stirton 10555*).

curvture 1,5 mm; stigma capitate, small. **Fruits** 6 -- 7 mm long, 3,5 -- 4,0 mm wide, papery, reticulate, pubescent. **Seeds** 3,5 -- 4,0 mm long, 2,5 -- 2,7 mm wide, khaki to chestnut brown, hilum central. Fig. 9.111.

O. gazense is usually found as a solitary, occasional plant of east and south aspect slopes of mountain grasslands, the edges of forested gulleys in montane grassland, and along streambanks. It occupies similar habitats to *O. caffrum*, *O. wilmsii*, *O. foliosum* and *O. fumeum* and may become quite invasive in disturbed areas such as firebreaks. It occurs between 1000 -- 2500 m in altitude. Flowering may take place all year round. There are, however, distinct peaks of flowering in January, February, July and December.

O. gazense is a rather variable species and two groups require further study in the field.

Group A is centred in the Northern Transvaal of South Africa and occurs in Blaauberg, Houtbosch, Kratzenstein, the Mohlakeng Plateau and on the Zoutpansberg. This group is characterized as follows: leaves with rounded apices, and even-sized, prominent, raised, nigropunctate glands; calyces silvery with the keel lobe much longer than the other four lobes. Typical specimens are: *Breyer* s.n. (PRE 55393); *Codd & Dyer 9149*, *Esterhuysen 21418*, *Gillett 2906*, *Grobbelaar 2906*, *Hemm 587*, *Hoffmann 120*, *Pole Evans 909*, *Rehmann 6268*, *Rodin 4068*, *Strey 7993*, *Van Niekerk 2906*.

Group B occurs in Eastern Zimbabwe, and on the Zoutpansberg Mountains and the eastern Transvaal Drakensberg Mountains of South Africa. In Zimbabwe it is found at Melsetter, Glencoe Forest Reserve, Stonehenge and in the Chimanimani Mountains. In South Africa it is centred near Haenertsburg, Magoebaskloof, New Agatha, The Downs and on the southern slopes of the Zoutpansberg. This group has khaki-coloured

seeds, more compact inflorescences, shorter calyces, more sunken glands. The leaves dry a much darker colour than those of Group A and are less rounded, hairy on both surfaces and have more sunken glands. The plants are much taller, more open-branched shrubs. This group is somewhat intermediate between *O. gazense* and *O. wilmsii*. The lower calyx lobe is very distinct in bud. Typical specimens are: *Codd 8420*, *Drummond 4999*, *Drummond & Phipps 288*, *Goodier 212*, *Marais 76*, *McCallum* s.n. (PRE 55339), *Meeuse 9779*, *Scheepers* s.n., and *Strey 1886*.

O. gazense is most commonly confused with *0. wilmsii* and *O. foliosum*. It differs from these two species in its emarginate or obtuse leaflets, habit, and broadly ovate standard. From *O. wilmsii* it differs in the rounded apex of the keel petals, shortly peduncled inflorescences, leaves with a short recurved mucro and its oblanceolate fruit. *O. wilmsii* has beaked keel petals, long peduncled inflorescences overtopping the subtending leaves, aristate mucro, and an oblong fruit. *O. foliosum* differs from *O. gazense* in its larger flowers, obovate standard, position and nuber of inflorescences, and in its fruit.

Specimens examined:

-1832 (Umtali): Rhodes Estate, District Inyanga (--BA), 29-1-1944, *Hopkins 11690* (K); Inyanga (--BA), 18-12-1930, *Fries, Norlindh & Weimarck 3801*; 24-4-1954, *Chase 4934* (PRE 2820); 6-1922, *Eyles 3558* (BOL); Inyanga district, mountain top (--BA), 11-1951, *Miller B/241* (K, PRE); Rhodes Inyanga Estate (--BA), 1-1936, *Pardy P16/36* (K); Inyanga (--BA), 13-1-1931, *Norlindh & Weimarck 4240* (K, PRE); Rhodes, Inyanga Orchards (--BC), 23-3-1966, *Simon 762* (K, PRE); Stapleford Ford Reserve (--DB), 12-6-1934, *Gillilard 276* (K, PRE); 7-7-1932, *Brain 9403* (PRE).

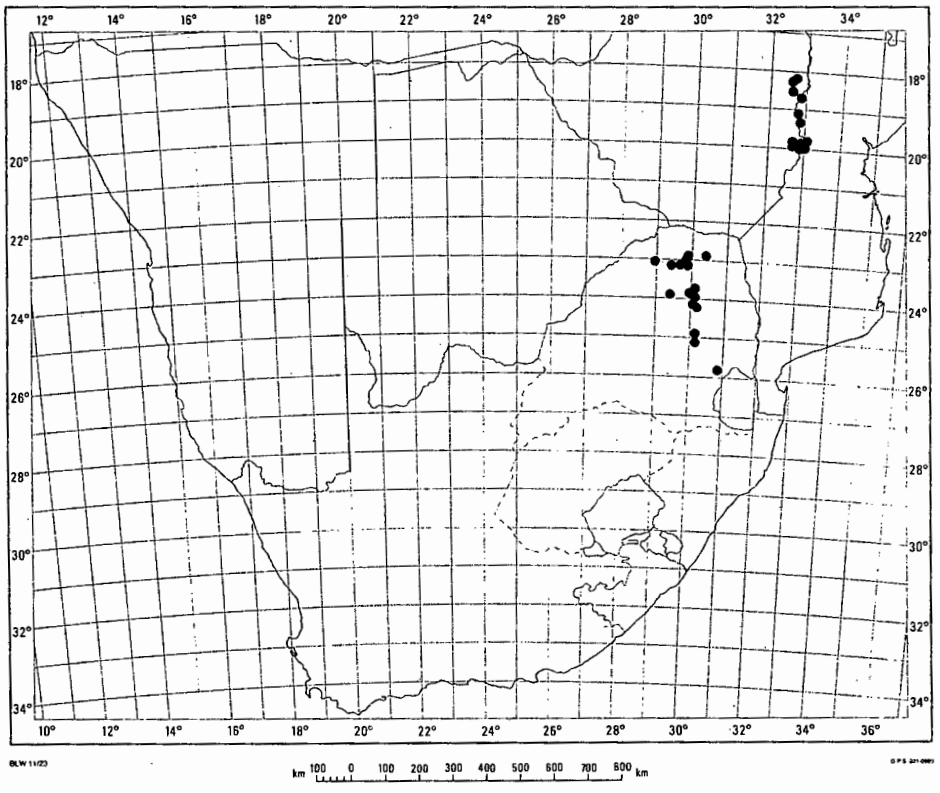

Fig. 9.112 Known distribution of *Otholobium gazense* (Baker) C.H. Stirton in southern Africa.

-1932 (Melsetter): Vumba, Zimbabwe (--BA), 9-1953, *Whellan 740* (PRE); Shigadowa Farm, SE Vumba Mts.; 30-6-1957, *Corner* s.n. (E); Umtali District, Barti North, Zimabwe (--BD), 21-7-1947, *Fisher 1358* (PRE); Mutema Highland, Chipinga (--DC), 4-1955, *Cowan 6155* (K); Thornton farm (--DC), 6-8-1950, *Crook M48* (PRE); Kasipiti (--DD), 1-6-1966, *Loveridge 1594* (K); Glencoe Forest Reserve (--DD), 24-11-1955, *Drummond 4999* K, PRE); Tarka Forest Reserve (--DD), 4-1968, *Goldsmith 39* K); Melsetter (--DD), 25-4-1947, *Wild 1957* (K); 20-9-1907, *Swynnerton 1417* (K, BM); 22-7-1943, *Hopkins 10283* (K); 24-2-1957, *Goodier 212* (K, PRE).

-1933 (Vila Pery): Stonehenge (--CC), 2-2-1958, *Drummond & Phipps* 288 (BOL); Chimanimani Mountains (--CC), 2-6-1948, *Munch 125* (K, PRE); 29-2-1907, *Johnson 216* (K).

-2229 (Waterpoort): between Louis Trichardt and Wylies Poort (--DD), 16-12-1928, *Gillett 2906* (BOL, STE); 9 km W of Wylies Poort (--DD), 22-8-1930, *Hutchinson & Gillett 4406* (K); Hangklip (--DD), 7-1959, *Van Der Schyff 6621* (PRE); 4 km N of Louis Trichardt (--DD), 30-7-1974, *Botha 853* (PRE, PUC).

-2230 (Tzaneen): Tate Vondo near Uitkyk (--CD), 17-4-1979, *Van Wyk 2718* (PU); Tate Vondo Forest Reserve (--CD), 28-3-1978, *Hemm 587* (PRE).

-2328 (Baltimore): Blaauwberg Glade farm (--BB), 30-1-1968, *Strey 7993* (BOL, K, NH, PRE); Blaauwberg (--BB), 27-12-1923, *Smuts & Pole Evans 909* (K, PRE); 5-5-1933, *Leemann 27* (PRE); 5-5-1933, *Esterhuysen 21418* (BOL, K); Mohlakeng Plateau (--BB), 13-1-1955, *Codd & Dyer 9149* (PRE).

-2329 (Pietersburg): 30 km W of Mountain Inn (--AB), 25-2-1957, *Meeuse 9779* (K, PRE); 20 km W of Louis Trichardt (--BA), 8-12-1956, *Prosser 2020* (PRE); 7 km above Louis Trichardt (--BA), 9-3-1948, *Rodin 4068* (K, PRE); Louis Trichardt (--BA), 10-8-1929, *Galpin 55395* (K, PRE); 1-12-1933, *D'Arcy* s.n. (PRE 55397); 2-1919, *Breyer* s.n. (PRE 55393); 6-1915, *Rogers 21148* (PRE); 22-5-1927, *Young 26458* (PRE); 7-1958, *Van Der Schyff 4435* (K, PRE, PU, W); Piertersburg (--CD), 25-2-1963, *Bayliss 1171* (PRE); 25-12-1925, *Leendertz 394* (PU); Kratzenstein (--DD), 3-3-1932, *Hoffmann 120* (PRE); 3,6 km N of Haenertsburg (--DD), 6-2-1947, *Story 1886* (K, PRE); 21-12-1925, *Leendertz 356* (PU); Haenertsburg (--DD), 6-1906, *Burtt Davy 2906* (K); 29-1-1954, *Codd 8420* (K, PRE); Olifants River Kloof (--DD), 25-7-1935, *Nel 159* (PRE, STE).

-2330 (Tzaneen): Duiwelskloof (--CA), 3-1960, *Scheepers 1509* (PRE); New Agatha (--CC), 10-3-1919, *McCallum* s.n. (PRE 55339); Wolkberg 634LT (--CC), 25-4-1971, *Muller & Scheepers 220* (K, PRE); Westfalia Estate (--CC), 7-10-1959, *Scheepers 712* (K, PRE, W); 30-3-1967, *Grobbelaar 43* (PRE); Houtbosch (--CC), 1875, *Rehmann 6268* (K); *Taylor 691* (PRE).

-2430 (Pilgrims Rest): Lekgalmeeste Nature Reserve (--AA), 13-8-1985, *Stalmans 584* (PRE); The Downs (--AA), 2-1919, *Junod 4368* (PRE, Z); 7-1917, *Rogers 20209* (K, NH, PRE); 27-1-1953, *Marais 76* (PRE); Lulu Mountains (--CC), 3-9-1936, *Mogg 16956* (K, PRE); Graskop (--DD), 18-7-1935, *Nel 128* (STE).

-2530 (Lydenburg): Elandsspruitberg (--AA), 7-12-1893, *Schlechter 3889* (BOL, G, K, PRE).

Without precise locality: Farm Fleurfontein 401, 15-2-1934, *D'Arcy* s.n. (PRE); Skyffontein, Zoutpansberg Mountains, 23-7-1935, *Galpin 14927* (K); Franzhoek Peak, 10-7-1935, *Galpin 14895* (K, PRE); between Pietersburg and Shilouvane, 4-1901, *Junod 1649* (G); Kimba Mountain, 12-9-1925, *Peter 30853* (K); 5,5 km E of Forthill, 19-10-1959, *Schlieben & De Winter 7983* (K).

49. Otholobium wilmsii (Harms) C.H. Stirton in S. Afr. J. Bot. 52: 4 (1986).

Psoralea wilmsii Harms in Bot. Jahrb. 26: 286 (1899); Forbes in Bothalia 3: 136 (1930); Burt Davy., Ferns & Flowr. Pl. Trans. 374 (1932); Compton, Fl. Swaziland 264 (1976), cited as *Psoralea pinnata* L. Holotype: near Lydenburg, *Wilms 295* (Z, holo; G, K, U, iso).

Erect, virgate, 1,0 -- 1,5 m tall shrub. **Stems** 1 to 5, branching from near the base; leafy in upper parts only. **Leaves** digitately trifoliolate, glaucous, erecto-patent, nigropunctate in dried material, glands considerably more numerous on upper surface, petiolate. **Leaflets** subequal, symmetrical, oblanceolate or to linear-oblanceolate, laterals more narrowly oblong; 25 -- 45 mm long, 7 -- 11 mm wide, apex rounded to obtuse, mucro arching, curved at tip, mucronate, base acute to cuneate, sparsely sericeous on both surfaces, persisting below but retained on veins of the upper surface of older leaves; glands more numerous on upper surface, raised, drying black; petiole 2 -- 3(5) mm long; petiolules 1 mm long. **Stipules** 3 -- 5 mm long, spreading, linear, senescent, persistent. **Inflorescences** axillary, numerous, up to 30 flowers borne on each seasonal shoot, cylindrical, as long as the subtending leaves; comprised of 5 -- 10 triplets of flowers, each triplet subtended by a 2,0 -- 2,5 mm long, 1 mm wide, triangular, pubescent, glandular bract. **Flowers** 8 -- 9 mm long, pale mauve to white; pedicels 2 -- 3 mm long. **Calyx lobes** 4 -- 6 mm long, tube 2,5 -- 3,0 mm wide; teeth unequal, triangular; carinal lobe longest, 6 mm long, narrowly triangular, vexillar and lateral lobes 3 -- 4 mm long, vexillar lobes fused above the tube, sericeous, teeth ciliate, hairs white, occasionally blackish, glands quite distinctive, scattered over whole surface, but most dense on the keel tooth. **Standard** 9 -- 10 mm long, 5,0 -- 6,5 mm wide, claw 2,0 -- 2,5 mm long, broadly ovate to elliptic, emarginate, auriculate; white or pale mauve with a large purple patch above the nectar guide. **Wing petals** 8,5 -- 9,0 mm long, 2 mm wide, claw 2,5 -- 3,0 mm long, auriculate, narrow, overlapping; white; sculpturing present, upper central,

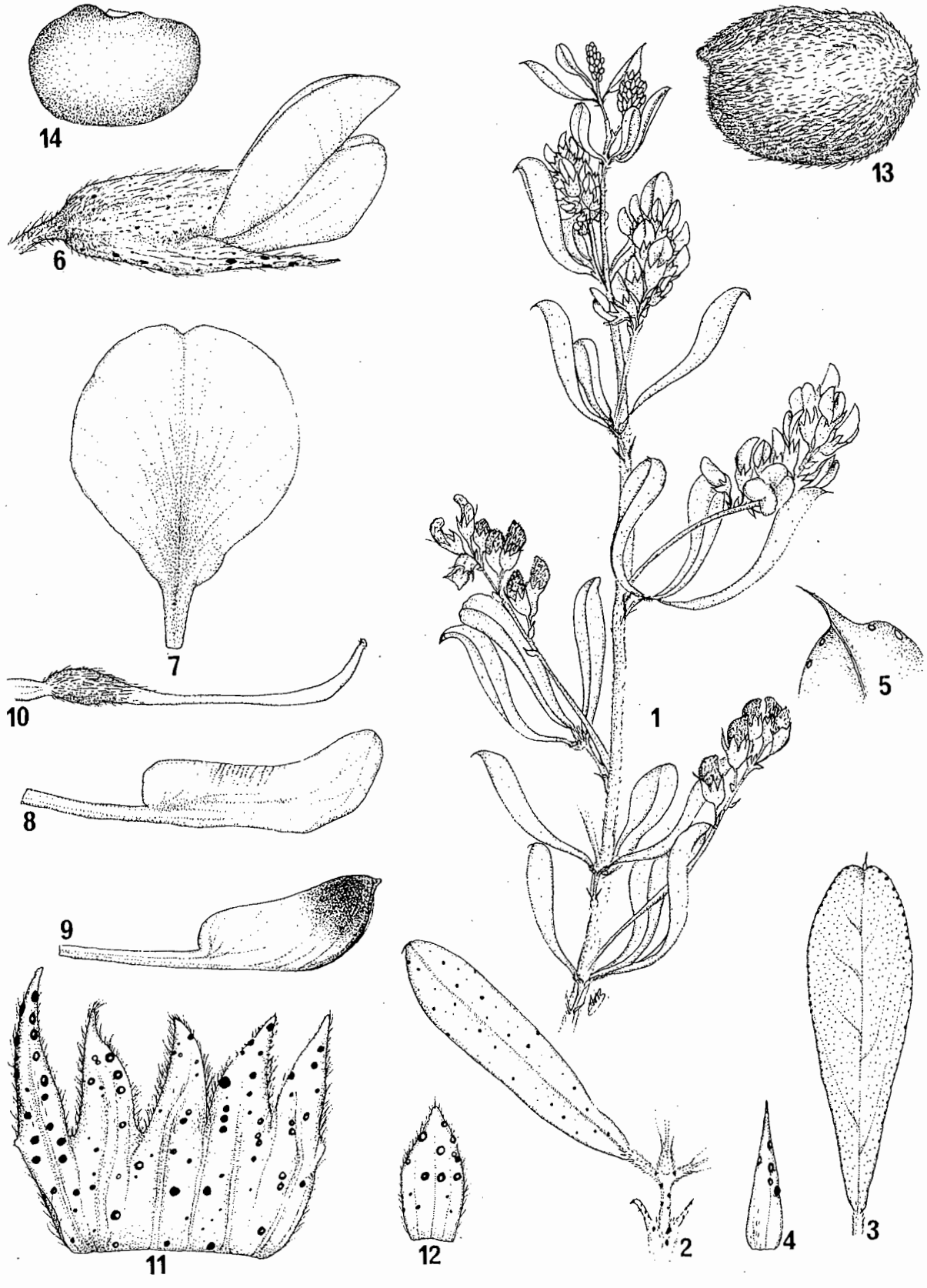

Fig. 9.113 *Otholobium wilmsii*. 1, Flowering shoot, x1; 2, Lateral leaflet of digitately trifoliolate leaf, upper surface, x1,5; 3, Terminal leaflet, lower surface, x1,5; 4, Stipule, x7; 5, Apex of terminal leaflet, x5; 6, Flower, x7; 7, Standard, x6; 8, Wing petal, x8; 9, Keel petal, x8; 10, Pistil, x10; 11, Calyx opened out, inner face, x10; 12, Triplet bract, x10; 13; Fruit, x6; 14, Seed, x7 (1-12, *Compton 28693*; 13-14, *Williams 7670*).

comprised of up to 20 irregular variously long transcostal lamellae. **Keel petals** 6 -- 7 mm long, 2,0 -- 2,3 mm wide, claw 3,5 mm long, shorter than wing petals. **Androecium** 6 -- 7 mm long, slit adaxially, vexillar stamen fused lightly in lower half; fenestrate. **Pistil** 6 -- 7 mm long; ovary 1,5 mm long, gynophore 1,0 -- 1,5 mm long; shaggy; height of curvature 2,0 -- 2,3 mm long; upper part of style sloping forwards; stigma penicillate, capitate. *Fruits* 7 mm long, 3,5 mm wide, somewhat thickened, hoary. **Seeds** 4 mm long, 3 mm wide, dark chesnut brown; hilum central, round. Fig. 9.113.

Otholobium wilmsii, like *O. nigricans,* is a distinctive endemic of the North East Mountain Sourveld (Acocks Veldtype No. 8) and the North Eastern Sandy Highveld (Acocks veldtype No. 57) regions of northern Natal, south-eastern Transvaal and north-western Swaziland (Fig. 9.114). It can be found growing along forest margins, on rocky outcrops in *Themeda*-dominated grassland and in open grassland, at an altitude between 1500 -- 2100 m. These areas receive between 750 -- 950 mm summer rainfall per annum (Acocks, 1975). The two species are however only rarely found growing together. Flowering is sporadic and protracted from November to August with peaks in November, January and March.

O. wilmsii is most closely related to *O. nigricans* and is distinguished from that species by its erecto-patent glaucous leaves, cylindical elongating inflorescences, white sericeous calyces and flower buds and oblong fruits. *O. nigricans* has more spreading lustrous green leaves with yellowish margins, subcapitate scarcely elongating inflorescences, densely black-haired calyces and flower buds and differently shaped fruits.

Specimens examined

-2529 (Witbank): Farm Pomplaats, Middelburg (--CD), *Le Strange* s.n. (PRE 55392).

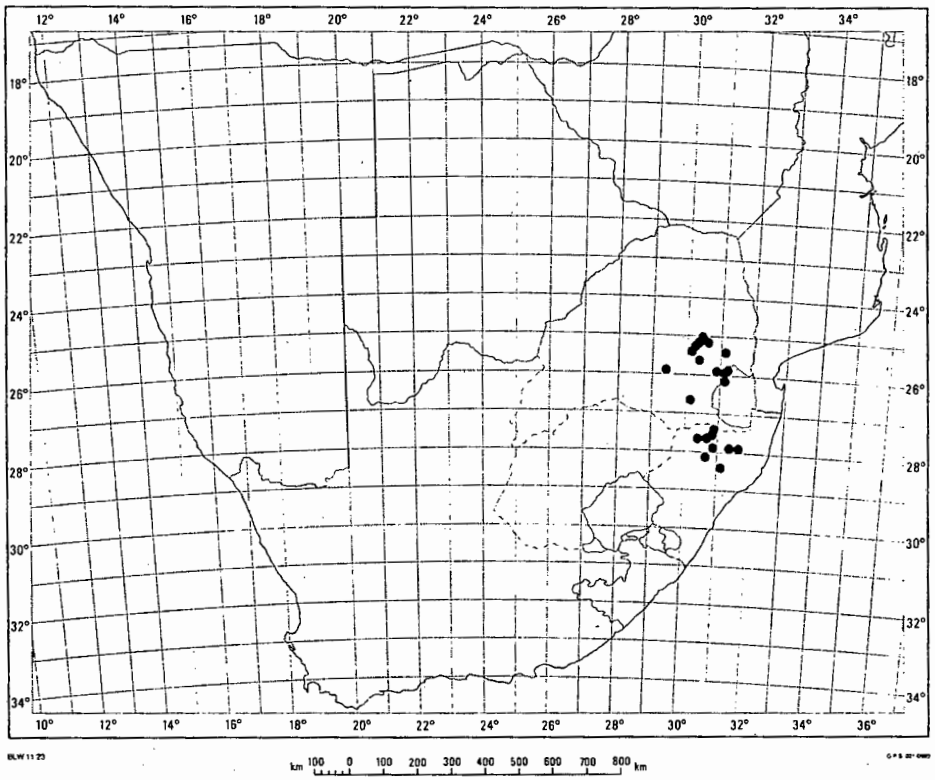

Fig. 9.114 Known distribution of *Otholobium wilmsii* (Harms.) C.H. Stirton in southern Africa.

-2530 (Lydenburg): Lydenburg (--AB), 12-1892, *Wilms 295* (K); 1-1895, *Wilms 5823* (PRE); 16,4 km from Lydenburg to Dullstroom (--AB), 23-2-1986, *Van Wyk 1878* (RAU); Spekboom River (--AB), 19-11-1933, *Young 448* (PRE); Zwaggershoek (--AB), 1-1930, *Obermeyer 185* (PRE); Dullstroom (--AC), 25-1-1933, *Galpin* s.n. (BOL 32234, PRE 55391); 1 km from Dullstroom to Lydenburg (--AC), 23-2-1986, *Van Wyk 1886* (RAU); Hartbeesvlakte (--BA), 6-3-1979, *Kluge 1753* (PRE); Farm Kaalbooi, 7 km from Waterval-Boven (--CB), 9-1-1978, *Jacobsen 4846* (PRE); Schoonoord (--DD), 22-4-1976, *Botha 1507* (PRE).

-2531 (Komatipoort): Mavieriestad (--CD), 11-1915, *Pott 5087*, (BOL, PRE); Barberton (--CC), 7-1907, *Thorncroft 4361* (PRE); 10-11-1909, *Williams 4361* (PRE, W); Havelock Mine (--CC), 21-3-1961, *Compton 27819* (K, PRE); King's Bush (--CC), 3-1961, *Miller 7796* (G, K, PRE).

-2631 (Mbabane): Silotwani Hills, Mbabane (--AA), 22-1-1957, *Compton 26507* (K, PRE); 20-3-1959, *Compton 28693* (PRE).

2730 (Vryheid): Retirement (--CB), 21-2-1961, *Devenish 602* (PRE); 3-3-1966, *Devenish 1322* (K, NU); Nkambule (--DA), 13-3-1944, *Gerstner 4633* (PRE); Zungwini Mountain (--DB), 3-2-1968, *Hilliard 4790* (K, NU, PRE); Hlobane (--DB), 12-3-1950, *Johnstone 350* (NU); Vryheid (--DD), 4-12-1912, *Burtt-Davy* s.n. (PRE 11423); 29-11-1929, *Galpin 9687* (PRE).

-2731 (Louwsburg): 29 km from Nongoma to Vryheid (--CD), 14-5-1981, *Stirton 8913* (PRE); 14-5-1981, *Schrire 398* (NH); 35 km from Nongoma to Vryheid (--CD), 14-5-1981, *Stirton 8921* (K, PRE); Ngomi Heights (--CD), 7-1936, *Verdoorn 1698* (K, PRE); 8-5-1944, *Gerstner 44460* (PRE).

-2830 (Dundee): 9 km E of Nqutu (--BA), 27-12-1946, *Codd 2410* (K, PRE).

-2831 (Nkandla): Nhlazatshe (--AA), 29-5-1960, *Ward 3402* (NU); 19-12-1966, *Burtt & Hilliard 3329* (NU); Babanango (--AC), 1933, *King 231* (NU, PRE).

Without precise locality: Swaziland, 12-1905, *Bolus 11794* (BOL, PRE); Wolhuterskop, 8-1909, *Crawley* s.n. (PRE 10406); 7-1865, *Gerrard 136* (K); Vryheid district, 4-1942, *Bradley 12* (NU).

50. Otholobium fumeum C.H. Stirton, *sp. nov.; O. caffri (Eckl. & Zeyh.) C. H. Stirton affinis, sed floribus majoribus, calyce pubescente, fructibus longioribus differt.*

Typus: Mlambonja Valley, 7-1936, *Marriott* s.n. (K, holo; Pre 22645, iso).

Frutex virgatus deciduus usque 3 m altus. Caules 1 -- 2, valde costati, verrucosi, juventute patento-pubescentes glabrescentes. Folia trifoliolata, spiraliter disposita, patentes. Stipulae 3 -- 4 mm longae, persistentes, appressae, subulatae. Foliola variabilia, in caule quam ea flores subtendentia maiora, terminale 30 -- 55 mm longum, 18 -- 35 mm latum, lateralia minora, obovata vel latissime obovata, emarginata, arcuato-mucronata, base obtusa vel cuneata; juventute appresse atro-pubescentia, demum superne glabra, inferne sparse, in margine densius, appresse pilosa; in sicco superne dense, inferne sparsius, minute nigro-punctata, glandulis superne magnitudine aequales, inferne magnitudine diversis; graveolentia; petiolus (5)15 -- 30(40) mm longus; petioluli 1,0 -- 1,5 mm longi; rachis 5 -- 10 mm longa. Inflorescentiae dense racemosae, in ramulis annuis brevibus 50 -- 100 mm longus terminales, interdum ramulos principales longioribus usque 300 mm longis terminantes; folia a quibus subtenta multo excedentes; pedicelli florium 2,5 -- 3,5 mm longi; flores in gregibus 20 -- 25 trifloris aggregati, grege omni a bractea singularis pubescenti 3 -- 4 mm longa, 1,5 -- 3,0 mm lata lanceolata subtenta, bracteis apicalibus angustioribus. Flores albi, lilacino-effusi, 8 -- 9 mm longi. Calycis lobi 6 mm longi, tubus 4 mm longus; dentes triangulares, quam tubum paulum breviores, < 1 mm late, dentibus vexillaribus quam aliis magis connatis; dentes omnes extus dense atro-velutini intus glabri; calyx extus ubique subtiliter regulariter glandulosus. Vexillum 9 -- 10 mm longum, 7 -- 8 mm latum, late ellipticum. Alae quam carina 3 mm longiores, 9 mm longae, 2,5 -- 3,0 mm latae. Petala carinae 6,5 mm longa, 2 mm lata. Androecium 6,5 mm longum, stamen vexillare in dimidio inferiore connatum; vagina in dimidio inferiore connata, fenestrata. Pistillum 6 mm longum; ovarium 2 mm longum pilosum, parte curvata 1,5 mm alta; stylus ad partem flexuosam in-

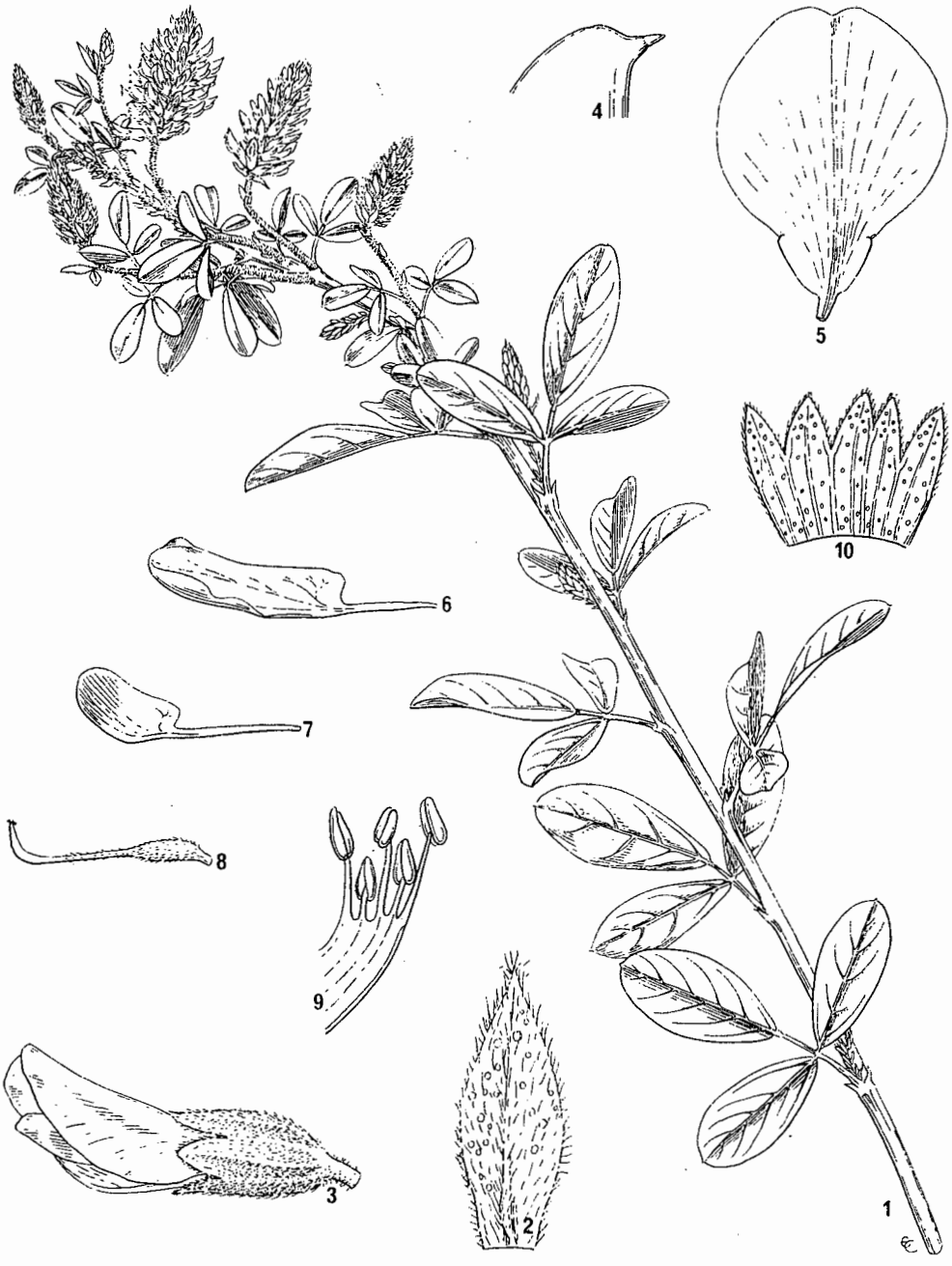

Fig. 9.115 *Otholobium fumeum*. 1, Flowering branch, x0,8; 2, Triplet bract, x10; 3, Side view of flower at anthesis, x6; 4, Apex of terminal leaflet, x10; 5, Standard, x5; 6, Wing petal, x5; 7, Keel petal, x5; 8, Pistil, x5, 9, Upper part of androecial sheath split in half to show arrangement of stamens, x20; 10, Calyx opened out, inner face, x5 (*Marriott* s.n.).

crassatus; stigma capitatum, papillosum. Fructus 8 mm longi, 3 -- 4 mm lati, pilis brevis atris patentibus obtecti, apice acuti, margine inferiore convexi, superiore recte extremitatem versus convexo. Semina 3,5 mm longa, 2,5 mm lata, castanea, hilo centrali.

Virgate deciduous shrubs up to 3 m tall. **Stems** 1 -- 2, distinctly ribbed, verrucose, patently hairy when young becoming glabrous when older. **Leaves** trifoliolate, inserted spirally, spreading. **Stipules** 3 -- 4 mm long, persistent, appressed, subulate. **Leaflets** variable, stem leaflets larger than those subtending inflorescences, terminal leaflet 30 -- 55 mm long, 18 -- 35 mm wide, laterals smaller, obovate to very broadly obovate, emarginate, mucro arching, base obtuse to cuneate; young leaflets covered in black appressed hairs, mature leaflets glabrous above, sparsely appressed hairy below, denser along margins; minutely and densely nigro-punctate above in dry state, less so below, glands even sized above, variously sized below; strongly smelling; petiole (5)15 -- 30(40) mm long; petiolules 1,0 --1,5 mm long; rhachis 5 -- 10 mm long. **Inflorescences** densely racemose, terminal on short 50 -- 100 mm long, seasonal shoots, occasionally terminating longer leader shoots up to 300 mm long; greatly exceeding subtending leaves; comprised of 20 -- 25 triplets, pedicels 2,5 -- 3,5 mm long; each triplet subtended by a single, pubescent 3,0 -- 4,0 mm long, 1,5 -- 3,0 mm wide, lanceolate bract; bracts being narrower towards the apex. **Flowers** white, flushed with lilac, 8 -- 9 mm long. **Calyx lobes** 6 mm long, tube 4 mm long; teeth triangular, slightly shorter than tube, < 1 mm wide, vexillar teeth fused higher up; all teeth densely black velutinous outside, glabrous inside; finely and evenly glandular over the entire calyx. **Standard** 9 -- 10 mm long, 7 -- 8 mm wide, broadly elliptic, claw 3 mm long, scarcely auriculate, appendages absent, apex emarginate. **Wing petals** 3 mm longer than keel, 9 mm long, 2,5 -- 3,0 mm wide with 3,0 -- 3,5 mm long claw, undulate, incurving at tip; sculpturing present, upper central comprised of 10 -- 12 vertical, irregular, transcostal lamellae. **Keel petals** 6,5 mm long, 2 mm wide with 3,0 -- 3,5 mm long claw. **Androecium** 6,5 mm long, vexillar stamen fused for half its length; sheath

fused for lower half, fenestrate; stamens equal. **Pistil** 6 mm long; ovary 2 mm long, hairy, height of curvature 1,5 mm; style thickened at point of flexure; stigma capitate, papillose. **Fruits** 8 mm long, 3 -- 4 mm wide, covered in short black patent hairs, apex acute, lower margin convex, upper margin straight becoming humped near the end. **Seeds** 3,5 mm long, 2,5 mm wide, chestnut brown, hilum nearly central. Fig. 9.115.

Otholobium fumeum is common wherever it occurs and is to be found predominantly along rocky riverbanks and streams, in gulleys, along forest margins and to a lesser extent in shrubby or tall grassland on steeper slopes of the northern Drakensberg Mountains (Figs. 9.116-117). It occurs between the altitudes of 1600 -- 3200 m and is found predominantly in Acocks's (1970) Highland Sourveld (VT-44) and less so in the lower parts of his *Themeda-Festuca* Alpine Veld (VT-58). These areas receive from 750 -- 1900 mm rainfall per annum, falling mainly in summer. Winter frosts are severe and snow falls at the higher elevations. This species is deciduous during the winter months, an unusual occurrence in the genus, and probably reflects the harsh winter climate it is exposed to. Flowering is protracted and takes place between April and November with peaks in July and October.

The Zulu common name for this species is **Insipili**. The specific epithet *fumeum* refers to the smoky appearance of the grey woolly calyces clustered tightly in the compact inflorescences.

O. fumeum is most closely related to *O. caffrum* but differs from that species in its narrower leaflets, larger flowers, densely black velutinous calyces with inner face of teeth glabrous and lanceolate flower bracts.

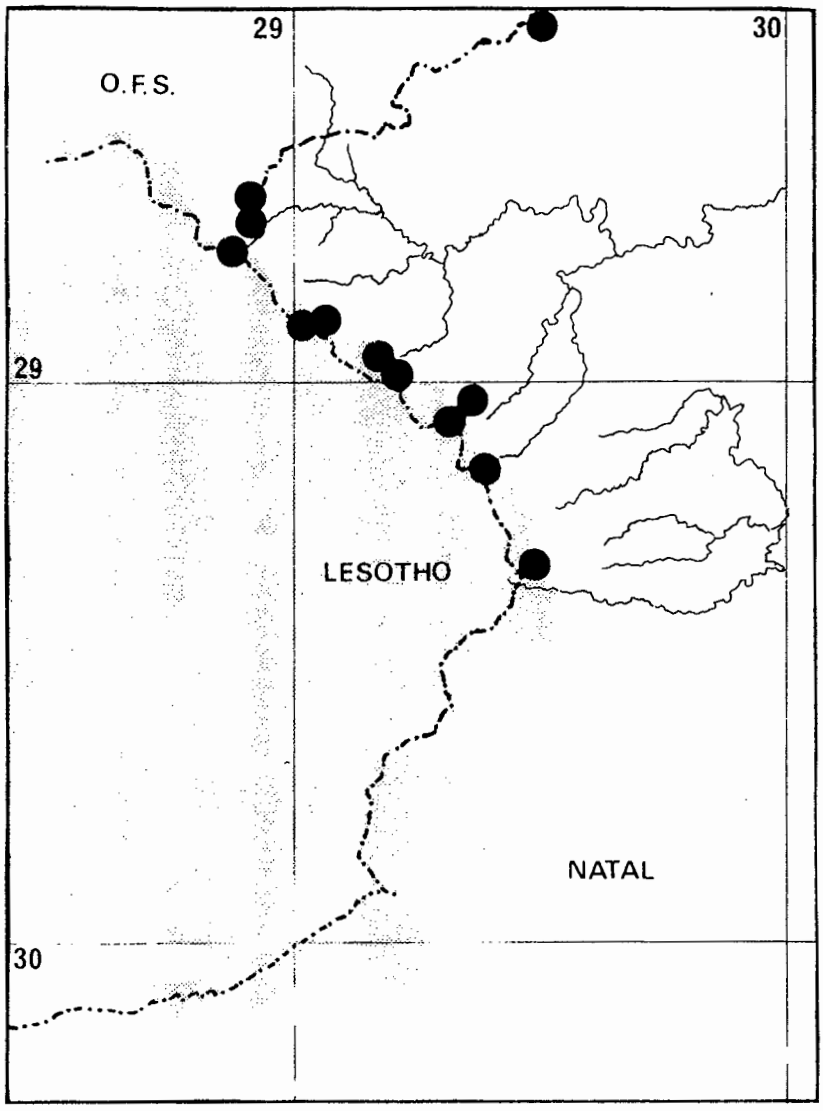

Fig. 9.117 Higher resolution map of the distribution of *Otholobium fumeum* C.H. Stirton in southern Africa.

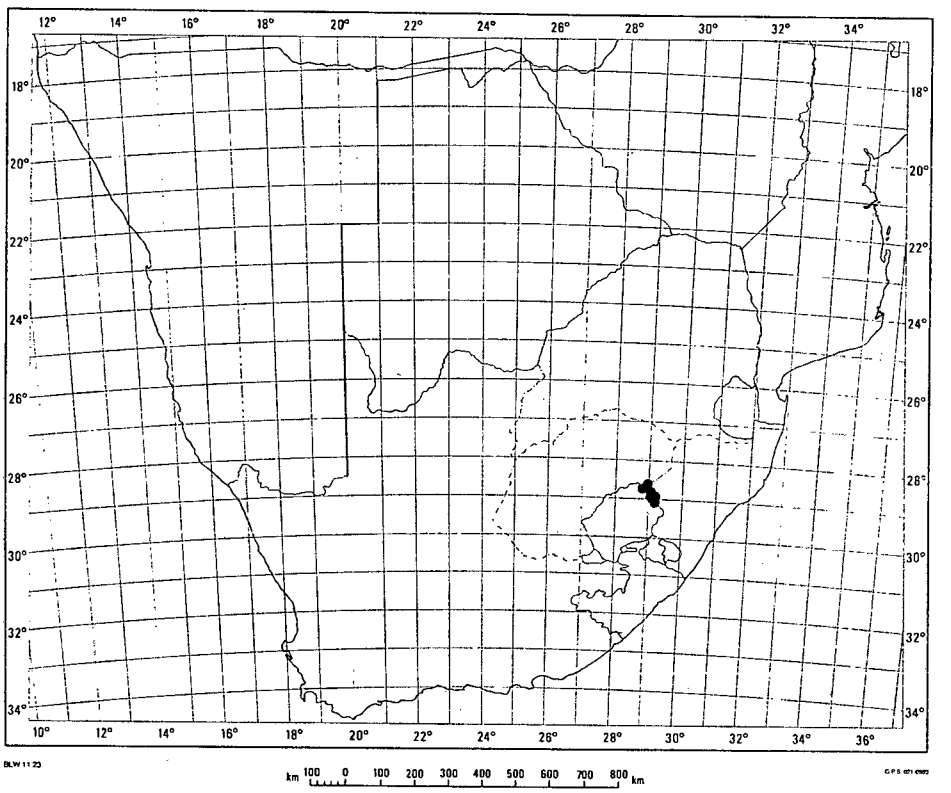

Fig. 9.116 Known distribution of *Otholobium fumeum* C.H. Stirton in southern Africa.

Specimens examined

-2828 (Bethlehem): Gulu Forest (--DB), 26-10-1955, *Edwards 966* (NU, PRE); Plowman's Kop (--DB), 29-10-1938, *Hafstron & Acocks 704* (PRE); Tugela Gorge, Natal National Park (--DB), 18-4-1964, *Hilliard 2864* (NU); 23-8-1950, *Martin 431* (NBG); *Lanjouw 1006* (U); 28-7-1930, *Hutchinson 4510* (K); 11-1927, *J. E. Oliver 452* (NH); Mont-aux-Sources (--DD), 3-1932, *Bruyn 31* (PRE); 1-10-1950, *Sidey 2025* (PRE); 28-8-1930, *Hutchinson, Forbes & Verdoorn 32* (K, PRE); 6-1921, *Sim* s.n. (NU, PRE); 8-4-1975, *Steyn 1088* (PRE); 6-10-1946, *Allanson 3* (NU).

-2829 (Harrismith): Cathedral Peak (--CC), 10-1960, *Rusch 1463, 2256* (PRE); 6-10-1952, *Dohse 61* (NH, PRE); 7-1944, *Esterhuysen 10233* (BOL); 7-1946, *Esterhuysen 12912* (BOL); 7-1948, *Harding 42* (E, NU); 4-8-1947, *Levyns 8252* (NBG); 24-7-1942, *Schelpe 57* (NU); Masongwana Valley (--CC0, 10-4-1985, *Getliffe* s.n. (NU); Upper Sinyati River Valley (--CC), 19-7-1955, *Edwards 848* (NU, PRE); Mnweni River (--CC), 7-1953, *Esterhuyzen 21673* (BOL, PRE); 7-1976, *Esterhuysen 34319* (BOL, E); Mlambonja Valley (--CC), 7-1936, *Marriott* s.n. (K, PRE 22645); Gudu River (--DB), 24-11-1948, *Galpin 10377* (PRE); Camel (--DB), 2-9-1942, *Germain 1572* (NBG); Outer Mnweni Needle (--DC), 20-7-1972, *Taylor 8137* (STE).

-2929 (Underburg): Injasuti (--AB), *Evans 664* (K); between Champagne Castle and Cathkin Peak (--AB), 9-1-1947, *Strey 1751* (PRE); Giants Castle (--AD), 21-10-1907, *Wood 10674* (NH, SAM).

Without Precise Locality: Mountain Hostel, 16-4-1937, *West 140* (K, PRE), *252* (PRE); The Caverns, Hlolehla, 11-1963, *L'ange 75* (NU); Spitzkop, Emangweni, 10-1890, *Thode 83149* (STE); Bushmans River Valley, 28-10-1907, *Wood 10674* (NH).

51. Otholobium nigricans C. H. Stirton, *sp. nov., O. wilmsi affinis sed foliis magis patentibus nitentibus margine lutescentibus; inflorescentiis subcapitatis vix elongatis, calycibus alabastrisque dense nigro-pilosis, fructibus oblongis differt.*

Typus: 2730 (Vryheid): Wild Game Park (--DD), 15-5-1981, *Stirton 8923* (PRE, holo).

Frutex erectus usque 1,5 m altus. Caules 1 -- 2, superne multiramosi. Folia digitatim trifoliolata, nitento-viridia, margine lutescentia, patentibus, aliquantum cucullata, glandulis in sicco luteo-brunneis vel aurantiacis superne valde luteoribus; breviter petiolati. Stipulae 2 -- 4 mm longae anguste lanceolatae vel lineares, semipatentes, glandulosae, pubescentes. Foliola 25 -- 45 mm longa, 9 -- 12 mm lata, lateralibus minoribus, oblanceolata, apice obtusa vel rotundata, breviter mucronata; folia vetustioria glabra, nitida, junioria molliter puberula; petiolus 3 -- 4 mm longus; petiolulus 1 mm longus. Inflorescentiae axillares, numerosae, usque 17 in omni ramulo annuo, subcapitatae, vix folia a quibus subtentae aequantes; flores in gregibus 5 -- 6 trifloris aggregati, grege omni a bractea 2 mm longa, 1,0 -- 1,5 mm lata obovata vel truncata dense glandulosa atro-pilosa subtenta; inflorescens junior atrissima. Flores 7 -- 9 mm longi virido-albidi vel pallide malvini, fragrantes; pedicelli 2,0 -- 2,5 mm longi bracteis ad caespitem pilorum nigrorum reductis. Calycis lobi 4,5 -- 5,0 mm longi, 1,5 mm lati; tubus 3 mm longus; dentes inaequales, costis prominentibus; lobus carinalis quam dentes quattuor alii aequali triangulares longior; lobi vexillares ultra tubo non connati; calyx extus et in facie interiore dentium dense atro-pilosus, dentibus ciliatis; in vitro luteo-viridis et glandulis viride luteis ornatus. Vexillum 6 -- 9 mm longum, 7 -- 8 mm latum, late ovatum, facie interiore purpuro-viridi, dorso viridi-brunneo et purpureo-fasciato. Alae 8 -- 9 mm longae, 2 mm latae, quam carina longiores. Petala carinae 5 --7 mm longa, 2 mm lata. Androecium 7 mm longum, adaxialiter fissum; stamen vexillare in dimidio inferiore connatum. Pistillum 6 -- 7 longum; ovarium 2 mm longum, dense hirtum, gynophoro

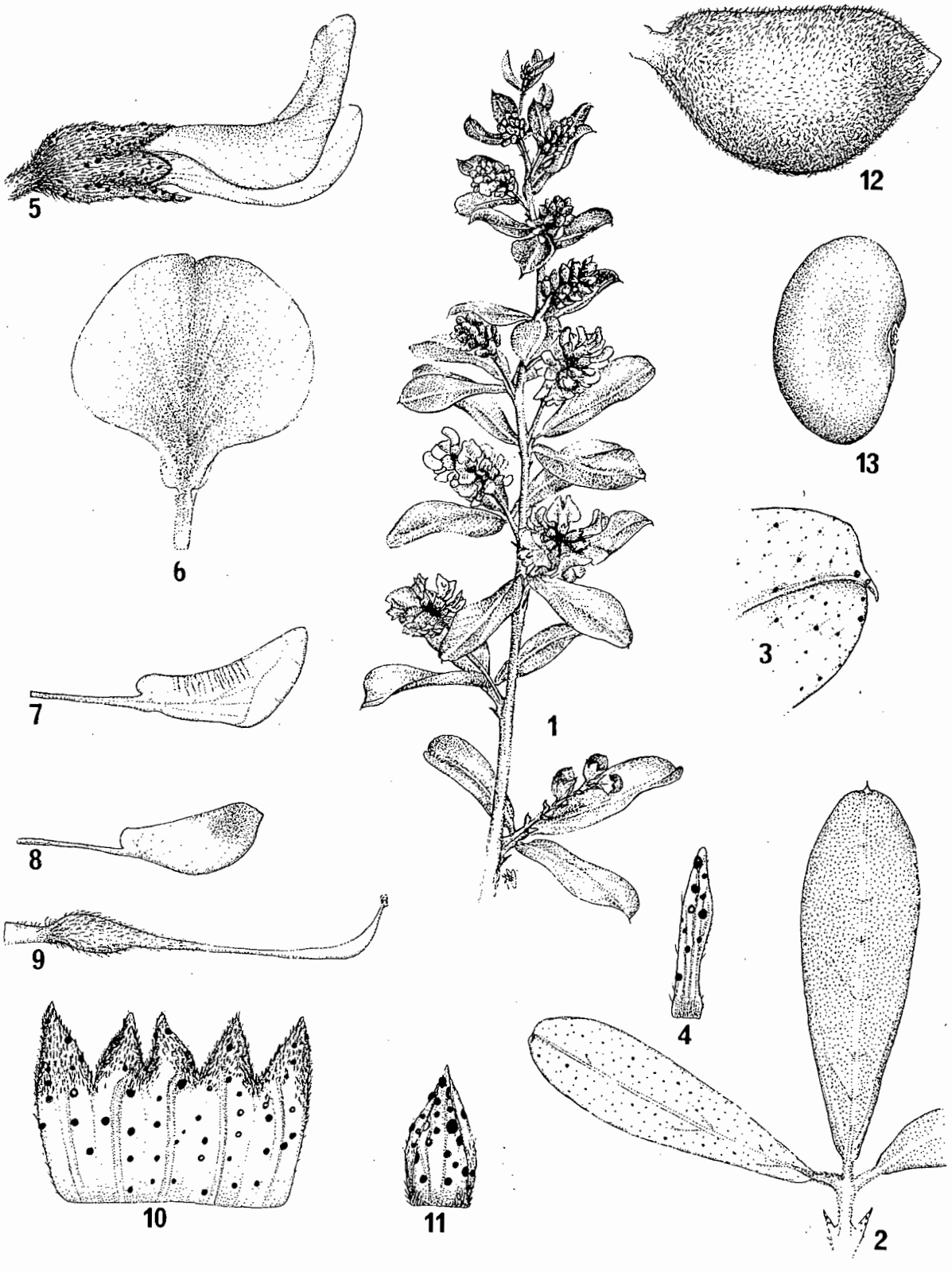

Fig. 9.118 *Otholobium nigricans*. 1, Flowering shoot, $x^2/_3$; 2, Digitately trifoliolate leaflet, terminal showing upper surface, left lateral showing lower surface, x1,5; 3, Apex of terminal leaflet, x3; 4, Stipule x7; 5, Side view of flower, x6; 6, Standard, x5,5; 7, Wing petal x5,5; 8, Keel petal, x5,5; 9, Pistil, x9; 10, Calyx opened out, inner face, x6,5; 11, Triplet bract, x11; 12, Fruit, x8; 13, Seed, x11 (*Stirton 8923*).

1,5 mm longo; parte curvata 1,5 mm alta, stylo in parte superiore prorsus inclinatus, entase ante partem curvatam evoluto; stigma capitata. Fructus 6 mm longi, 3,5 mm lati, dense atropilosi. Semina 3,5 mm longi, 2,5 mm lati, viridibrunnea, hilo centrali.

Erect densely leafy shrubs up to 1,5 m tall. **Stems** 1 -- 2, much-branched in upper parts. **Leaves** digitately-trifoliolate, lustrous green, margins yellowish, patent, somewhat cucullate, glands drying yellowish-brown to orange, considerably yellower on upper surface; shortly petiolate. **Stipules** 2 -- 4 mm long, narrowly lanceolate to linear, semi-patent, glandular, pubescent. **Leaflets** 25 -- 45 mm long, 9 -- 12 mm wide, laterals smaller, obovate to oblanceolate, apex obtuse to rounded, shortly mucronate; older leaves glabrous, nitid, younger leaves softly puberulous; petiole 3 -- 4 mm long; petiolules 1 mm long. **Inflorescences** axillary, numerous, up to 17 on each seasonal shoot, sub-capitate, scarcely elongating, same length as the subtending leaves, comprised of 5 -- 6 triplets of flowers, each triplet subtended by a 2 mm long, 1,0 -- 1,5 mm widely obovate or truncate, densely glandular black-haired bract; young inflorescence quite black. **Flowers** 7 -- 9 mm long, greenish white to pale mauve, sweetly-scented; pedicels 2,0 -- 2,5 mm long, bracts reduced to a small tuft of black hairs. **Calyx lobes** 4,5 -- 5,0 mm long, 1,5 mm wide, tube 3 mm long; teeth unequal, ribs prominent; carinal lobe longer than the other four equal triangular teeth, vexillar lobes not fused above the tube; densely black-haired pubescent on outer parts and on inner face of the teeth, teeth ciliate; yellowish green in fresh state with bright yellow glands. **Standard** 6 -- 9 mm long, 7 -- 8 mm wide, claw 2,0 -- 2,5 mm long, broadly ovate, emarginate, auriculate, inner face purplish green, back greenish brown with purple stripes. **Wing petals** 8 -- 9 mm long, 2 mm wide, longer than keel petals, claw 3 mm long, auriculate, billowy, narrow; sculpturing present, upper central, comprised of a single row of 16 -- 22 transcostal lamellae. **Keel petals** 5 -- 7 mm long, 2 mm wide, claw 3 mm long, upcurving, apex obtuse. **Androecium** 7 mm long, split adaxially, vexillar stamen fused for half its length. **Pistil** 6 --

7 mm long; ovary 2 mm long, densely shaggy, gynophore 1,5 mm long; height of curvature 1,5 mm long, upper part of style forward sloping, entasis developed before flexure; stigma capitate. **Fruits** 6 mm long, 3,5 mm wide, densely black-haired. **Seeds** 3,5 mm long, 2,5 mm wide, greenish brown, hilum central. Fig. 9.118.

Otholobium nigricans is a distinctive endemic of the North East Mountain Sourveld (Acocks veldtype No. 8) and the North Eastern Sandy Highveld (Acocks veldtype No. 57) regions of northern Natal, south-eastern Transvaal and north-western Swaziland (Fig. 9.119). It can be found growing along forest margins, on rocky outcrops in *Themeda*-dominated grassland and in open grassland, at an altitude between 1500 -- 2100 m. These areas receive between 750 -- 950 mm summer rainfall per annum (Acocks, 1975). Flowering is sporadic and protracted from January to August with peaks in January, May and July. The northern populations flower much earlier in the year than the Natal populations.

O. nigricans is most closely related to *O. wilmsii* and is distinguished from that species by its more spreading lustrous green leaves with yellowish margins, subcapitate scarcely elongating inflorescences, densely black-haired calyces and flower buds and differently shaped fruits. *O. wilmsii* has erecto-patent glaucous leaves, cylindical elongating inflorescences, white sericeous calyces and flower buds and oblong fruits.

Specimens examined

-2530 (Lydenburg): 9,2 km E of Dullstroom on road to Lydenburg (--AC), 21-5-1962, *De Winter 7720* (K, G, PRE); Waanhoop (--AC), 18-3-1980, *Germishuizen 1283* (K, PRE); Dullstroom (--AD); 30-1-1959, *Werdermann & Oberdieck 2029* (K, PRE); 21-1-1933, *Galpin* s.n. (BOL 322340); Belfast Commonage (--CA), 31-1-1929, *Hutchinson 2746* (BOL,

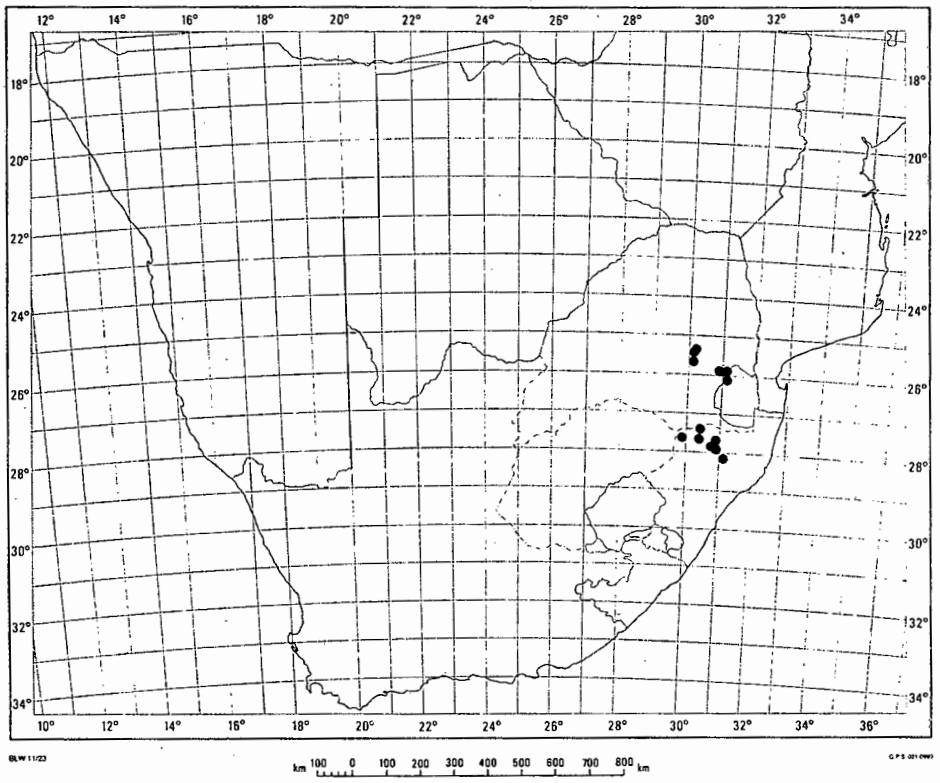

Fig. 9.119 Known distribution of *Otholobium nigricans* C.H. Stirton in southern Africa.

K, PRE); Nelsberg, Lydenburg (--DD), 26-2-1936, *Taylor 1909* (PRE).

-2531 (Komatipoort): Rimers Creek Gorge, Barberton (--CC), 26-7-1890, *Galpin 978* (K, PRE, SAM).

-2631 (Mbabane): Darkton Valley, Mbabane (--AA), 11-6-1958, *Compton 27875* (PRE).

-2729 (Volksrust): Farm Highlands, Volksrust (--DB), 7-5-1920, *Mogg 7468* (PRE).

-2730 (Vryheid): Naauwhoek, Utrecht (--AD), 28-7-1961, *Devenish 676* (K, PRE); Mooihoek (--AD), 11-5-1988, *Devenish 2102* (NU); Tweekloof, Utrecht (--CB), 8-11-1924, *Thode 374* (PRE); 3 km S of Paulpietersburg, Dumbe Mountain (--BD), 23-8-1947, *Codd 1727* (K, MEL, PRE); Vryheid Nature Reserve (--DD), 15-5-1981, *Schrire 401* (NH); 15-5-1981, *Stirton 8923* (PRE).

-2831 (Nkandla): Inhlazatshe (--AA), 6-8-1939, *Gerstner 3636* (PRE).

Without precise locality: 16-7-1937, *Smuts & Gillett 3584* (PRE).

52. Otholobium foliosum (Oliv.) C.H. Stirton in S. Afr. J. Bot. 52: 2 (1986).

Psoralea foliosa Oliv. in J. Linn. Soc., Bot. 21: 399 (1885); Battiscombe, Cat. Common Trees & Woody Pl. Kenya Colony : 61 (1936); Brenan & Greenway, Checklist Trees & Shrubs Br. Empire 2: 436 (1949); Dale & Greenway, Kenya Trees & Shrubs (1961); White, For. Fl. North. Rhod.: 161 (1962); Gillett in F. T. E. A. 4,2: 1011 (1971). Holotype: Laikipia [Lykipia], Kenya, *Thomson* s.n. (K).

Much branched erect shrub up to 3,5 m tall. **Branches** densely pubescent. **Leaves** digitately trifoliolate, crowded, shortly petiolate. **Leaflets** 7 -- 17 mm long, 2,5 -- 4,5 mm wide, oblanceolate; apiculate, mucro arching; flat, base acute or cuneate, margin undulate, pubescent, glands of upper surface smaller and more numerous than on lower surface; outline not distinct, somewhat sunken; petiole < 2 mm long; petiolules 1 mm long, pubescent. **Stipules** 2 -- 4 mm long, oblong-falcate, persistant, semi-patent. **Inflorescence** a crowded, dense, terminal, subcapitate raceme half-hidden by the subtending leaves or rarely 2 or 3 together in the axils of the upper leaves; comprised of 6 -- 8 triplets of pedicellate flowers, each triplet subtended by a persistent 3 -- 5 mm long ovate or obovate bract. **Flowers** 7 -- 10 mm long, subtending bracts 1,5 -- 3,0 mm long, linear to lanceolate; pedicel about 3 mm long. **Calyx** teeth about as long as the 3 mm long tube, unequal, keel lobe longer than rest, vexillar lobes not fused above the tube; pubescent with blackish hairs, sparsely glandular. **Standard** 9 -- 10 mm long, 7 -- 8 mm wide, claw 1 -- 2 mm long, obovate, apex retuse, auriculate. **Wing petals** 9 -- 10 mm long, 2 mm wide, claw 2,5 -- 3,0 mm long, longer than keel; sculpturing upper central, comprising up to 20 transcostal lamellae. **Keel petals** 7 -- 8 mm long, 2,3 -- 2,5 mm wide, claw 4 mm long, tip rounded. **Androecium** 7 mm long, sheath split adaxially, vexillar stamen adherent lightly. **Pistil** 7,0 -- 7,5 mm long; ovary 1 -- 2 mm long; stipitate, 1,0 -- 1,5 mm long; finely pubescent with black hairs; height of curvature 1,5 mm, style thickened at curvature; stigma

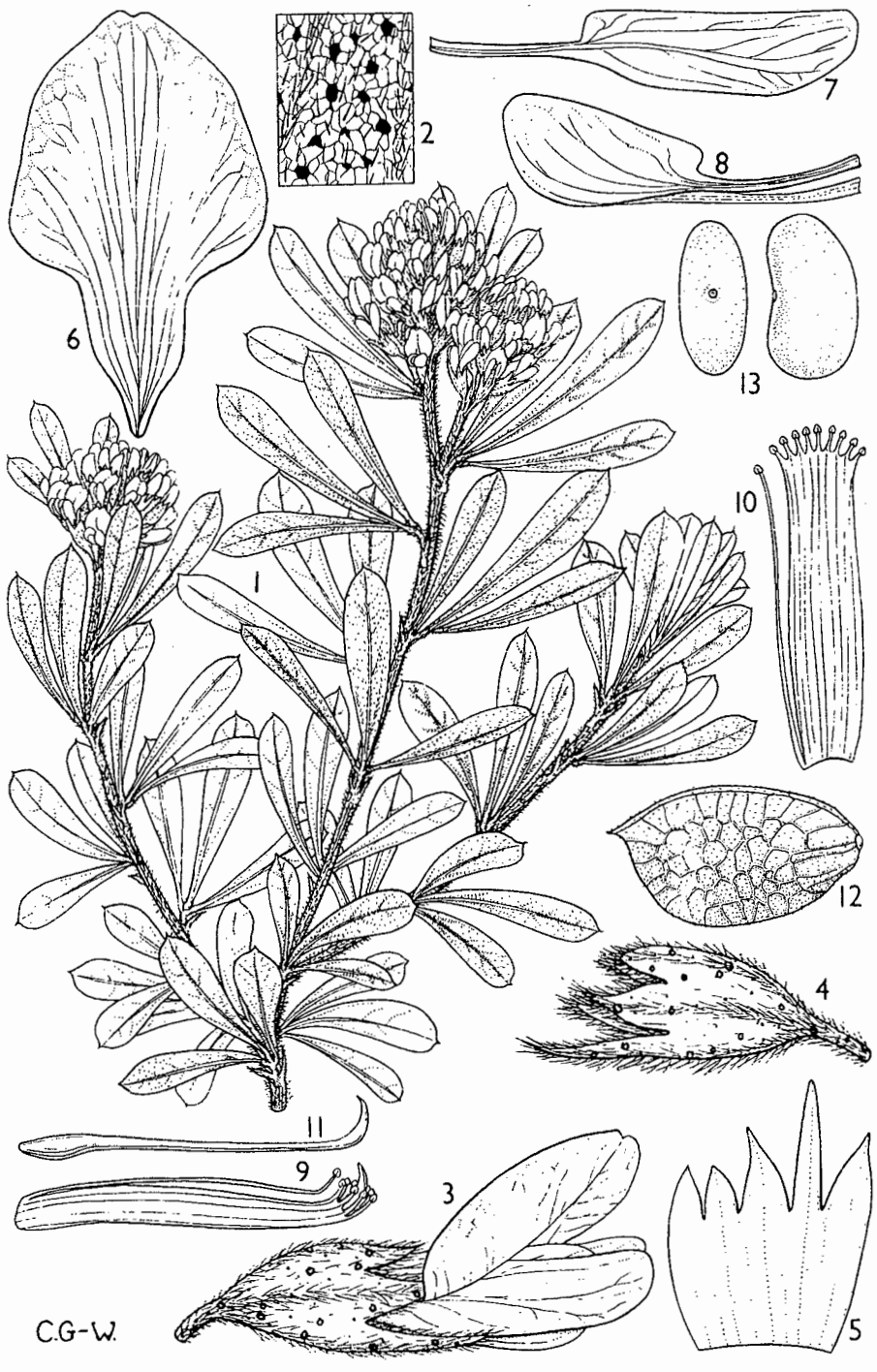

Fig. 9.120 *Otholobium foliosum*. 1, Flowering branch, x1; 2, Detail of leaflet surface above, x10; 3, Flower, x6; 4, Calyx, x6; 5, Calyx, opened out, inner face, x6; 6, Standard, x6; 7, Wing petal, x7; 8, Keel petal x6; 9, Stamens and pistil, x6; 10, Androecial sheath spread out, x6; 11, Pistil, x6; 12, Fruit, x6; 13, Seeds, x6 (1-11, *Milne-Redhead & Taylor 11007*; 13 & 14, *Lynes D.73*; Figure reproduced with kind permission of C. Grey-Wilson and Director, Royal Botanic Gardens, Kew).

minute, almost truncate, minutely papillose. **Fruits** 5 -- 7 mm long, 3 -- 4 mm wide, papery, prominently reticulate, puberulous. **Seeds** 3,5 -- 4,5 mm long, 2,5 mm wide, tan to dark brown, hilum central. Fig. 9.120.

Otholobium foliosum is the only species of *Otholobium* which extends beyond the Zambezi River (Fig. 9.121). It is a plant of montane *Ocotea - Podocarpus* forest margins, damp upland grassland, as well as along the margins of the drier highland *Juniperus* forest. It is distributed in south-western Kenya, north-eastern and southern Tanzania, and in northern Malawi. It occurs mainly on the following uplands: Mau Escarpment, Aberdares, Mt. Kenya, Cherangani Hills, Mt. Kilimanjaro, Crater Highlands, Poroto Hills, Kiringere Range, Mufindi and the Nyika Plateau.

Flowering in *O. foliosum* takes place throughout the year across the distribution range but with three peaks in February, May and October to November. In Kenya flowering is dominant in May and October-December; in Tanzania in February and September/October; and finally in Malawi in May and October.

Vernacular names include *Oloisongoyo* (Masai; fide *Glover, Gwynne & Sarnier, 1285*); *Mapegele, Mgohamola* (Kihehe); *Ruyuyu* (Kikuyu; Dale & Greenway, 1961).

Specimens examined

KENYA

K1: (Northern Frontier): Nyiru, 30-12-1955, *Adamson 537* (K).

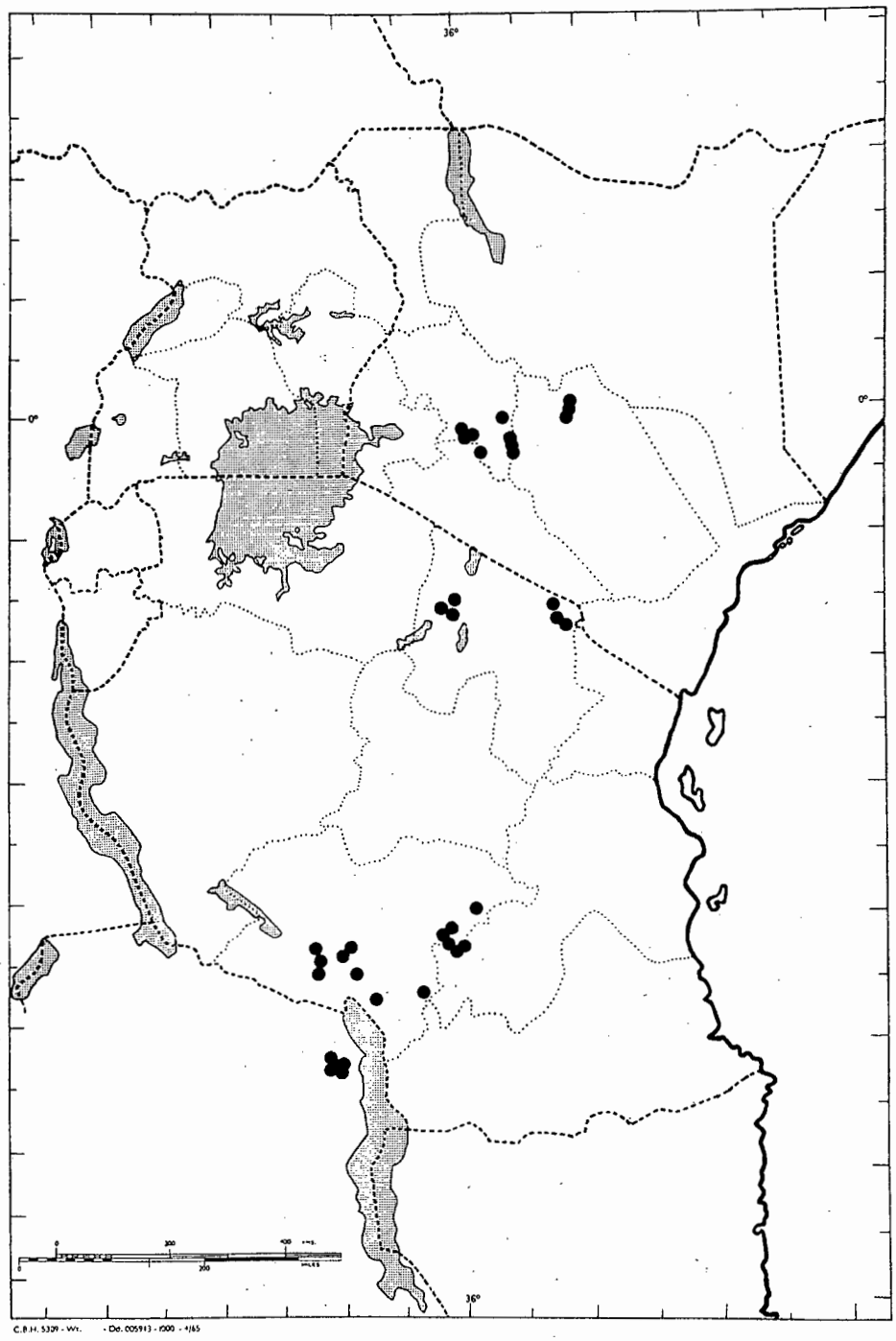

Fig. 9.121 Known distribution of *Otholobium foliosum* (Oliv.) C.H. Stirton in southern Africa.

PRE); 24-11-1980, *Ruffo 1601* (K); Lake Ngwazi Dam, 6 km N of Ngwazi, 11-8-1971, *Perdue & Kibuwa 11011* (K); near Lake Ngwazi, 10-5-1973, *Shabani 1004* (K); 16-9-1971, *Perdue & Kibuwa 11436* (K); upper part of Kimbwi River, 24-8-1952, *Carmichael 109* (K, PRE); near Lugoda Tea Estate, 11-5-1968, *Renvoize & Abdallah 2120* (K); 17-6-1978, *Thulin & Mhoro 3242* (K); Mayer's Farm, Mufindi West, 24-2-1932, *Thompson 633* (K). (Mbeya): Poroto Mountains, 8-3-1932, *Thompson 757* (K); Kikondo, 20-10-1956, *Richards 6651* (K); 12-5-1957, *Richards 9638* (K); 22-1-1961, *Richards 14124* (K). (Njombe): Njombe, 8-1931, *Hornby 1* (K, PRE); 3-12-1931, *Lynes 14* (K); 29-11-1931, *Lynes 73* (K); 16-12-1931, *Lynes 158* (K); Hagafiro, 11 km S of Njombe, 8-7-2956, *Milne-Redhead & Taylor 11007* (K); Ndumbi Forest Reserve, 2-1954, *Semsei 1618* (PRE); Ruhudje, Lupembe, 5-1931, *Schlieben 914* (BRUX, K).

MALAWI

(Nyika): Rumpi, Nyika Plateau, 16-6-1960, *Chapman 738* (K, PRE); 7-8-1970, *Hall-Martin 1668* (K); *Salubeni 365* (K); 1-10-1969, *Pawek 2880* (K); 15-8-1975, *Pawek 10038* (K); 4,5 km SW of Rest House, Nyika Plateau, 24-10-1958, *Robson & Angus 315* (K, PRE); Kangampande Mountain, 4-5-1952, *White 2552* (K); near Chelinda Camp, 16-11-1958, *Robson & Fanshawe 632a* (K); 15-11-1967, *Richards 22599* (K); Lake Kanlime, 15-11-1958, *Robson & Fanshawe 632* (K); 16-5-1970, *Brummitt 10810* (K); 4-1884, *Johnson* s.n. (K).

Without precise locality: Kenya, 12-10-1927, *Lyne Watt 1162* (K); *Elliott 423* (K); Western Aberdares, 1923, *Gardner 1120* (K); 1913, *Stolz 2208* (U).

53. Otholobium polystictum (Benth. ex Harv.) C.H. Stirton in S. Afr. J. Bot. 52: 3 (1986).

Psoralea polysticta Benth. ex Harv. in Harv. & Sond., Fl. Cap. 2: 150 (1862); Phillips in Ann. S. Afr. Mus. 16: 80 (1917); Jacot Guillarmod, Fl. Lesotho 194 (1971). *Lotodes polystictum* (Benth. ex Harv.) O.K., Gen. Pl. 3,2: 65 (1891). Holotype: Doornkop, Winburg district, Orange Free State *Burke* s.n. (K, holo; SAM 15410, iso).

Erect virgate shrub up to 2,5 m tall or a small laxly branched suffrutex up to 1 m tall. **Stems** flexuous, striate, hairy, glabrescent, glandular. **Leaves** digitately trifoliolate, petiolate, stipulate. **Leaflets** subequal, terminal longest, 20 -- 30 mm long, 10 -- 14 mm wide, obovate, nigro-punctate, laterals assymetrical; glands on lower surface much larger and more raised than the more numerous ones of the upper surface, glabrescent; apex rounded to emarginate, mucro arching, recurved at tip, base acute; petiole 2 -- 3 mm long, < 1 mm long. **Stipules** small, rapidly senescent, persistent, subulate, 2,0 -- 2,5 mm long. **Inflorescences** axillary in upper third of seasonal shoots; lax clusters of 2 -- 3 triplets of flowers, each triplet subtended by a bifid, oblong, ciliate, 2 mm long bract; peduncle 1 -- 2 mm long bracts, persistent, linear to narrowly lanceolate. **Flowers** 7 -- 9 mm long, pedicel 2 mm long. **Calyx** shorter than the corolla; lobes unequal, carinal lobe 6,5 -- 7,0 mm long, lanceolate; other lobes triangular, all teeth 1,2 -- 1,4 mm wide, vexillar pair fused above the 2,5 -- 3,0 mm tube for 1 mm, veins ridged; tomentulose, glands scattered all over surface. **Standard** 7 -- 9 mm long, 5 -- 6 mm wide, claw 2 mm long; broadly elliptic, emarginate, not prominently auriculate. **Wing petals** 7 -- 8 mm long, 2 mm wide, claw 3 mm long; auriculate, lightly fused to keel petal near auricles; sculpturing present, upper basal and upper left central, comprised of 10 -- 15 transcostal lamellae. **Keel petals** shorter than wing petals, 6,5 -- 7,0 mm long, 2 mm wide, 3,0 -- 3,5

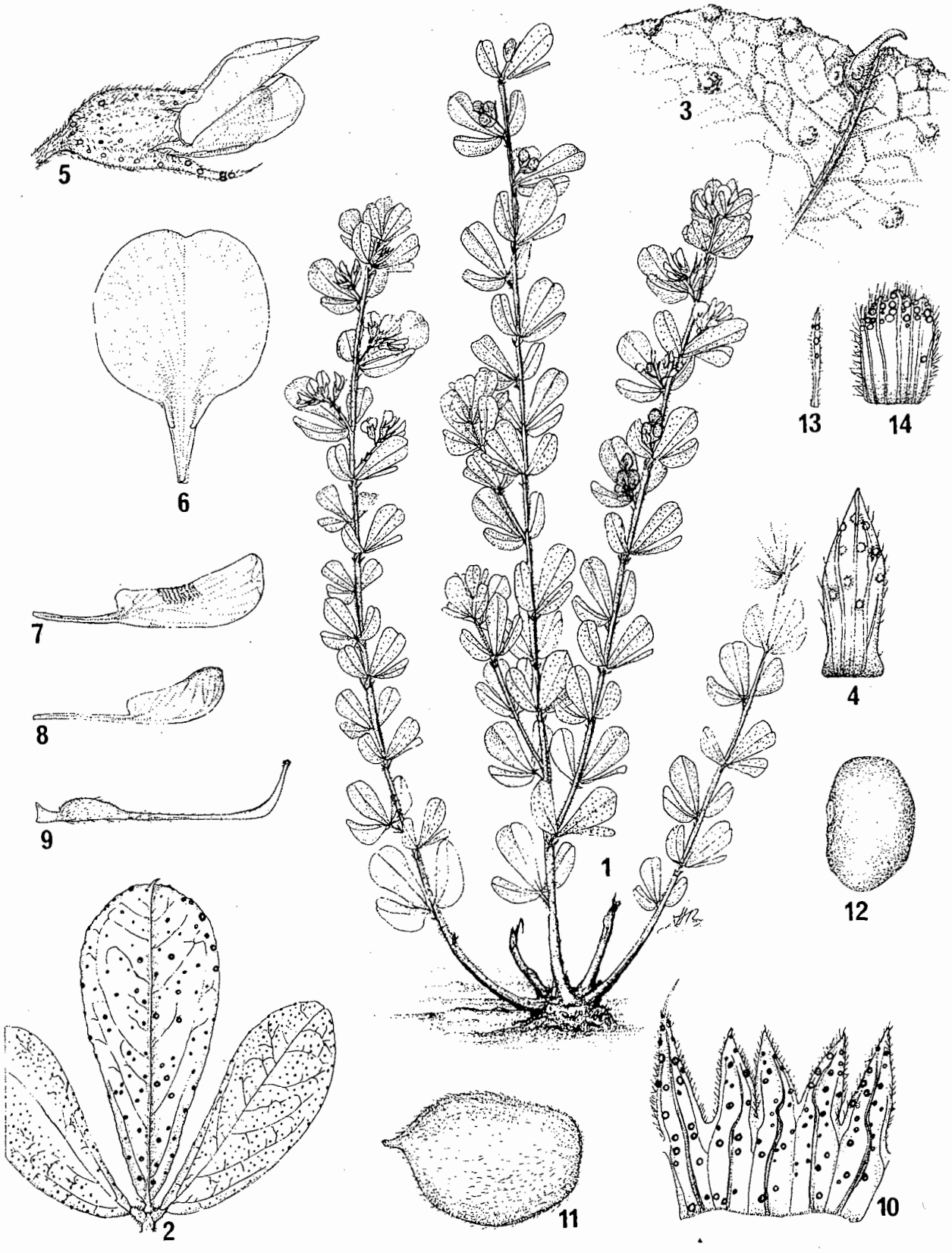

Fig. 9.122 *Otholobium polystictum*. 1, Flowering stems, $x^2/_3$; 2, Digitately trifoliolate leaf, terminal showing lower surface, laterals showing upper surface, x2; 3, Apex of terminal leaflet, x10; 4, Stipule; x10; 5, Flower, x5; 6, Standard, x5; 7, Wing petal, x5; 8, Keel petal, x5; 9, Pistil, x7; 10, Calyx opened out, inner face, x6; 11, Fruit, x7; 12, Seed, x7; 13, Flower bract, x10; 14, Triplet bract, x10 (1-10, 13-14, *Jacobsz 494*; 11-12, *McClean 760*).

mm long. **Androecium** 6 mm long, pseudomonadelphous, fenestrate. **Pistil** 5 -- 6 mm long; ovary 1,8 -- 2,0 mm long, shaggy, extending half way along the style, stipe 1 mm long, height of curvature 1,5 mm, entasis best developed before curvature, style after entasis forward-sloping; stigma small, capitate. **Fruits** 4 -- 6 mm long, 3,0 -- 4,5 mm wide, densely pubescent, glandular, reticulations not obvious. **Seeds** 3,0 -- 4,0 mm long, 2,5 mm wide, chesnut brown, hilum central. Figs. 9.122-123.

Otholobium polystictum is a localized component of the following Acock's Veld Types: North Eastern Mountain Sourveld, Highveld Sourveld and Dohne Sourveld, Bankenveld and Southern Tall Grassveld. It ranges from the Transkei and East Griqualand in the south to isolated outliers in the Waterberg Mountains in the Western Transvaal (Fig. 9.124). It is one of the few species that occurs in the Orange Free State.

O. polystictum is found predominantly on the sides of ravines, grassy mountain slopes, the banks of streams and scree slopes. The plants are said to favour doleritic outcrops and sandstone areas with a S and NE facing slope. Most collectors have commented on the scarcity of the plant, probably referring to its solitary habit. The species does, however, have the capacity to become quite invasive wherever the veld has been mismanaged (*Ward 402*). Flowering, like in *O. caffrum*, is protracted and sporadic and occurs throughout the year, peaking between January and March.

This species has been most confused with *O. caffrum*. It differs from that species in its many shortly pedunculate inflorescences hidden by the subtending leaves, hairy style and excentric lateral leaflets.

Specimens examined

Fig 9.123 *Otholobium polystictum*. 1, General habit, B. Schrire, *Indigofera* specialist, wondering whether it is a new species of *Indigofera* or not! 2, Close up of inflorescence, notice partially upflexed standard and drooping apices of the wing petals.

-2427 (Thabazimbi): Farm Groothoek 1246, western extremity of Waterberg Mountains (--BB), 7-4-1948, *Codd 3984* (PRE).

-2429 (Zebediela): Potgietersrust (--AA), 1-6-1946, *Maguire* s.n. (J 28271, PRE).

-2628 (Johannesburg): Aasvogelkop (--AC), 8-1930, *Gilmore 2188* (TCD, PRE); Diepkloof 314 (--AC), 3-7-1952, *Mogg 21463* (J, PRE); Schoongezicht 302, 19-11-1916, *Burtt-Davy 15435* (BOL); Boschhout (--AD), 8-2-1949, *Moss* s.n. (PRE); Boschkloof (--CA), 4-12-1971, *Bredenkamp 340* (PRE); Suikerbosrand Nature Reserve (--CA), 3-2-1986, *Van Wyk 1808* (RAU); 25-3-1970, *Lambrechts 221* (PRE); 7-2-1960, *Repton 5353* (K, PRE); Karreekloof (--CA), 16-10-1971, *Bredenkamp 155* (PRE); Tierkloof (--CB), 20-12-1971, *Bredenkamp 511* (PRE); Melville Koppies (--CA), 23-11-1978, *McMurty 2188* (PRE); 25-1-1976, *Hosken 20* (NU); 1-8-1960, *Macnae 1158* (BOL, J); 2-2-1986, *Van Wyk 1787* (RAU); Heidelberg (--CA), 11-1909, *Leendertz 7693* (PRE); Northcliff (--CA), 24-6-1950, *Mogg 19850* (K); Klip River (--CA), 4-1861, *Gerrard & McKen 440* (MEL 1542069, TCD).

-2631 (Mbabane): Hlatikulu (--CD), *Stewart 181* (SAM).

-2729 (Volksrust): Charlestown (--DB), 24-3-1897, *Wood 6331* (G, W); 22-3-1894, *Kuntze* s.n. (K); Glendale farm, Normandien (--DC), 18-12-1977, *Biggs 92* (PRE).

-2827 (Senekal): Winburg (--CA), *Burke* s.n. (K); Doornkop, Senekal (--DA), 7-12-1931, *Goossens 923* (K, PRE); Franshoek (--DD), 15-1-1964, *Van Zinderen Bakker 35* (K, PRE); Laagspruit (--DD), *Zeyher 449* (PRE, SAM 15410, S, TCD).

-2427 (Thabazimbi): Farm Groothoek 1246, western extremity of Waterberg Mountains (--BB), 7-4-1948, *Codd 3984* (PRE).

-2429 (Zebediela): Potgietersrust (--AA), 1-6-1946, *Maguire* s.n. (J 28271, PRE).

-2628 (Johannesburg): Aasvogelkop (--AC), 8-1930, *Gilmore 2188* (TCD, PRE); Diepkloof 314 (--AC), 3-7-1952, *Mogg 21463* (J, PRE); Schoongezicht 302, 19-11-1916, *Burtt-Davy 15435* (BOL); Boschhout (--AD), 8-2-1949, *Moss* s.n. (PRE); Boschkloof (--CA), 4-12-1971, *Bredenkamp 340* (PRE); Suikerbosrand Nature Reserve (--CA), 3-2-1986, *Van Wyk 1808* (RAU); 25-3-1970, *Lambrechts 221* (PRE); 7-2-1960, *Repton 5353* (K, PRE); Karreekloof (--CA), 16-10-1971, *Bredenkamp 155* (PRE); Tierkloof (--CB), 20-12-1971, *Bredenkamp 511* (PRE); Melville Koppies (--CA), 23-11-1978, *McMurty 2188* (PRE); 25-1-1976, *Hosken 20* (NU); 1-8-1960, *Macnae 1158* (BOL, J); 2-2-1986, *Van Wyk 1787* (RAU); Heidelberg (--CA), 11-1909, *Leendertz 7693* (PRE); Northcliff (--CA), 24-6-1950, *Mogg 19850* (K); Klip River (--CA), 4-1861, *Gerrard & McKen 440* (MEL 1542069, TCD).

-2631 (Mbabane): Hlatikulu (--CD), *Stewart 181* (SAM).

-2729 (Volksrust): Charlestown (--DB), 24-3-1897, *Wood 6331* (G, W); 22-3-1894, *Kuntze* s.n. (K); Glendale farm, Normandien (--DC), 18-12-1977, *Biggs 92* (PRE).

-2827 (Senekal): Winburg (--CA), *Burke* s.n. (K); Doornkop, Senekal (--DA), 7-12-1931, *Goossens 923* (K, PRE); Franshoek (--DD), 15-1-1964, *Van Zinderen Bakker 35* (K, PRE); Laagspruit (--DD), *Zeyher 449* (PRE, SAM 15410, S, TCD).

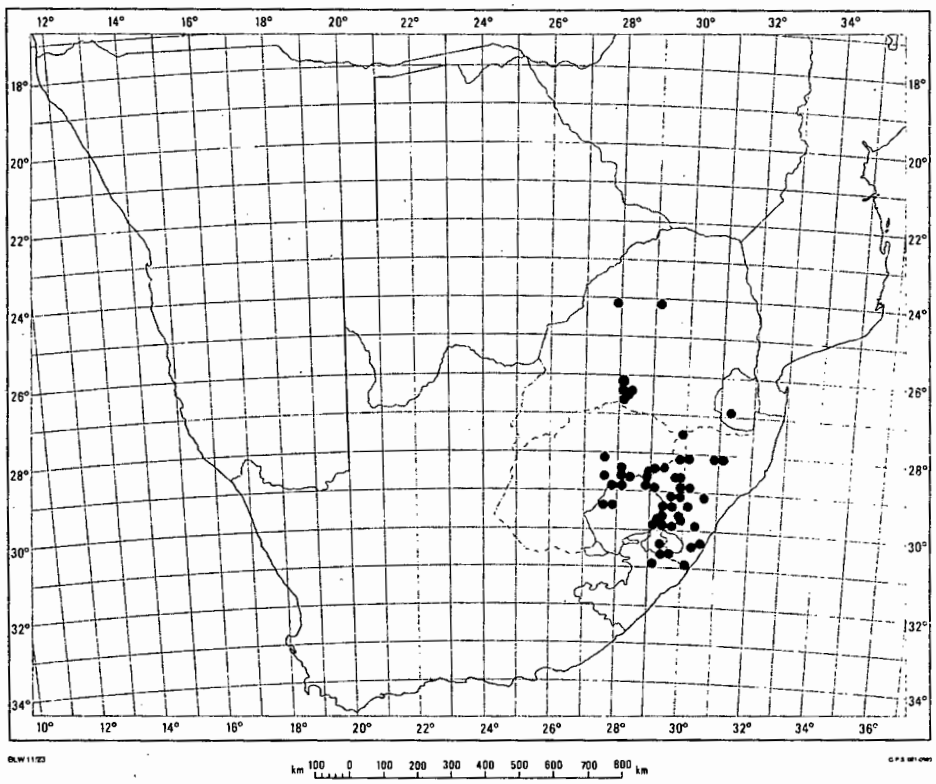

Fig. 9.124 Known distribution of *Otholobium polystictum* (Benth. ex Harv.) C.H. Stirton in southern Africa.

-2828 (Bethlehem): Rautenbachs (--CA), 1-1896, *Thode 6357* (STE); Klein Thaba Basigo (--CA), 11-3-1973, *Scheepers 1854* (K, PRE); Dusselm farm, Fouriesburg (--CA), *Potts 3083* (PRE); 4 km S of Carlens (--CB), 17-1-1957, *Marais 1285* (K, PRE); Leribe (--CC), *Dieterlen 372* (PRE, SAM); Witzieshoek (--DB), 3-1917, *Junod* s.n. (G); Mont Aux Sources (--DD), *Doidge* s.n. (PRE).

-2829 (Harrismith): Harrismith (--AC), 19-8-1905, *Sankey 41* (K); Rensburgskop farm, near Swinburne (--AC), 4-2-1963, *Jacobsz 494* (K, NBG); Manyenyeza Mountain, Van Reenens Pass (--AD), *Rehmann 7249* (K); Spioenkop (--BA), 27-10-1955, *Edwards 981* (NU); Estcourt Research Station (--BB), 11-12-1937, *West 486* (K, PRE); Umlambonja (--CC), 9-2-1954, *Schelpe 70* (K, BOL); Wagon Hill, Ladysmith (--DB), 29-11-1900, *Wood 8010* (MEL, NU, PRE); Colenso (--DB), 27-2-1894, *Krook 2498* (W); Renisbergspruit, Estcourt (--DD), 31-12-1974, *Green 68* (PRE).

-2830 (Dundee): between Dundee and Ndumeni (--AA), 20-6-1926, *Truscott 133* (PRE); Nqutu (--BB), 8-3-1935, *Gerstner 683* (PRE); Weenen (--CC), 12-1890, *Wood 9890* (G, SAM 15409).

-2831 (Nkandla): Inhlazatshe (--AA), 6-8-1939, *Gerstner 3636* (K, PRE), 25-9-1960, *Ward 3402* (PRE).

-2927 (Maseru): St Michaels, Roma (--BC), 13-3-1975, *Schmitz 6408* (PRE); 4-1977, *Schmitz 7506* (PRE), 4-1977, *Schmitz 7507* (PRE); between St Michaels and Rual (--BD), 11-1976, *Schmitz 6911a* (PRE).

-2929 (Underburg): Giants Castle Nature Reserve (--AB), 18-1-1965, *Trauseld 362* (NU); Ash Cave, Upper Loteni Valley (--AD), 4-2-1985, *Hilliard & Burtt 18083* (K, NU); Giants Castle Nature Reserve (--AD), 18-1-1965, *Trauseld 362* (PRE); Lowlands (--BB), 12-1941, *Schelpe 27* (NU); Tabamhlope (--BA), 14-3-1937, *West 88* (PRE); Estcourt (--BB), 7-2-1906, *Wood 9953* (ISC, MEL 1542070); Vechtlagter (--BB), 14-1-1944, *Acocks 10043* (NH, PRE); Tribuary of the Ka-Ntubu (--CB), 3-12-1982, *Hilliard & Burtt 15822* (NU); Bamboo Mountain (--CB), *Price* s.n. (K); Sani Pass (--CB), 13-1-1985, *Hilliard & Burtt 18051* (K, NU); Cobham Forest Reserve (--CB), 15-2-1979, *Hilliard & Burtt 12587* (E, NU); 16-12-1983, *Balkwill, Manning & Cadman 1116* (NU); Mzimude Pool (--CC), 25-6-1982, *Nicholas & Berg 1318* (PRE); Drakensberg Gardens (--CD), 7-2-1982, *Bamps* s.n. (PRE); 6-2-1982, *Lambion & Reekmans 338* (PRE); 18-4-1968, *Nicholson 681* (PRE); 27-1-1975, *Hilliard & Burtt 7750* (K, NU, PRE); near Mashai Pass (--CD), 3-2-1984, *Roux 1805* (NBG); Umzimkulu River (--CD), 3-1938, *McClean 760* (K, NH, PRE); Boston (--DB), 21-4-1905, *Wood 4032* (PRE); Loteni Nature Reserve (--DB), 20-1-1968, *Killick 3886* (K, PRE); Sunset farm (--DC), 5-1-1981, *Rennie 1236d* (NU).

-2930 (Pietermaritzburg): Weston (--AA), 12-1942, *Fisher 423* (NU); Nottingham Road (--AC), 3-1939, *McClean 882* (K, PRE); Greytown (--BA), 3-1890, *Wood 876* (MEL); Cunningham's Castle, above Byrne (--CC), 15-1-1985, *Nicholas & Neave 2101* (PRE); Richmond (--CD), 2-1927, *Thode 1206* (K, PRE).

-3029 (Kokstad); Mount Currie (--AD), 6-1883, *Tyson 1319* (E, G, GRA, K, PRE); Kokstad (--CB), 1-3-1966, *Coleman 320* (NH); Ntsizwa Mountain (--CC), 27-1-1895, *Krook 2590* (W); Weza (--DA), 1-1-1966, *Strey 6276* (K, NU, PRE); Ngeli slopes (--DA), 15-9-1963, *Hilliard 1764* (NU).

-3030 (Port Shepstone): Friedenau farm, Dumisa (--AD), 30-5-1909, *Rudatis 650* (G, PRE, W); Ellesmere, Umgaye Flats (--BC), *Rudatis 436* (STE); above Horseshoe Dam, Izingolweni (--CC), 9-8-1974, *Nicholson 1454* (PRE).

Without precise locality: O.F.S, 1862, *Cooper Cole 1114* (BOL, TCD, W); O.F.S., *Cooper Cole 2189* (K); Upper Umkomaas, 20-1-1966, *Killick & Vahrmeijer 3708* (K, NH, PRE); Griqualand East, 6-1883, *Tyson 519* (BOL, K); Bevaan Falls, 17-7-1883, *Wood 3191* (K); Blaauw Krantz, 24-12-1885, *Wood 3517* (NH, K).